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Australian Edelweiss at Mt Hotham: But for How Long?

The Australian Edelweiss *Ewartia nubigena* is an elusive creature, in line with its more famous and rather larger European cousin. It occurs mostly on exposed patches of shingle around the 1750 m level or above, appearing at first sight like a patch of grey moss or lichen, but revealing on closer inspection its tiny white daisy flowers.

Within the Mt Hotham Alpine Resort, which has recently been extended (by excision from the Alpine National Park) to accommodate new ski runs and facilities, there are, or have been, a few places where Edelweiss can be seen. On an inspection two years ago, the best of these was found just a short distance away from the Orchard Chair Lift Station, but this eluded me on a recent visit over New Year. Does it still exist? - I don't know. Another patch was previously seen deep down in the valley of Australia Drift, but could not be checked this time. However, the most accessible specimens were to be found, on this occasion (January 2001), as previously, growing **right at the very edge** of the 4WD track as it climbs from the Orchard Chair up to the summit ridge of Mt Loch. I gather from Jane Calder that it can be found elsewhere, such as on Mt McKay, as well as in the Kosciusko National Park at high altitude.

However, my dismay was considerable at discovering large drums of high voltage power cable laid out at intervals along the 4WD track, clearly about to be ripped into the track by a couple of D9s in tandem or whatever. This is evidently intended to be an alternative power supply to the Hotham Resort, connecting from the Gotcha Chair to the West Kiewa Power Station. It might appear to have come about as a result of opposition to a route via Dinner Plain to Omeo. However, it has the potential to make *Ewartia* very scarce indeed in Victoria, and any assurances that the area will be restored after the event are clearly rather hollow in respect of *Ewartia*.

It is a reminder that such things can happen very fast and be irreversible, and it is my hope that it will not be too late to save this unique alpine plant.

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Fig. 1. The patch of Australian Edelweiss which was found two years ago near the Orchard Chair Lift Station, Mt Hotham and could not be found again this year. Most Edelweiss patches are much smaller than this.

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Cover: The adult leaves of Buxton Gum *Eucalyptus crenulata* look like juvenile leaves. These mature leaves are an unusual characteristic of Buxton Gum. See article on p. 16. Photo: R. Adams.

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The Potential Impact of Freeways on Native Grassland

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Abstract

Transportation planning typically considers only the direct impacts of road construction, such as loss of vegetation and wildlife habitat. However, the ecological impacts of major roads and freeways are not confined to the area immediately adjacent to the road. Recent international research has demonstrated the existence of a 'road effect zone' around major roads and freeways. In Melbourne many current and proposed freeways traverse areas of native grassland. This paper presents a review of the major ecological impacts of roads and how they may affect native grasslands using the proposed Hume Freeway F2 Link as a case study. The road effect zone of the Hume Freeway F2 Link route options are quantified and the impacts on the native grasslands of the Merri Creek Valley assessed.
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Introduction

The past decade has seen many new freeways constructed in and around Melbourne. The Western Ring Road, City Link, Ringwood Bypass, Northern Ring Road and Eastern Freeway extension have been completed, the Deer Park bypass to link the Western Freeway and Western Ring Road is under construction and other proposed freeways are in the final planning stages. These include the Eastern Ring Road (Scoresby Freeway), a further extension of the Eastern Freeway through the Mullum Mullum Valley to Ringwood and the Hume Freeway F2 Link between Craigieburn and the Northern Ring Road. Most of these projects were subject to extensive environmental review through impact assessments, planning panel reviews and public hearings. Such studies tend to examine the direct impact of freeway construction on the biota. They typically assess the quality of the vegetation and occurrence of rare flora and fauna species along the proposed freeway alignment. However, recent international research has shown that the ecological impacts of freeways extend well beyond the area destroyed by the road and associated construction activities. The aim of this paper is to review the ecological impact of major roads on native grasslands and to discuss the concept of a 'road effect zone' using the proposed Hume Freeway F2 Link as a case study.

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Ecological Impact of Roads

More than 20 ecological effects of roads have been identified by scientists from around the world (Forman and Deblinger 2000). These include the dispersal of particulate and chemical pollutants, noise and introduced plants and animals (Forman 1995). Comprehensive reviews of the ecological effects of roads are provided by Bennett (1991), Forman (1995), Forman and Deblinger (1998), Spellerberg (1998) and Trombulak and Frissell (2000). Our intention here is to briefly discuss some of these effects to highlight the diverse range of impacts roads can have on the environment.

Sources of Pollution and Exotic Species

Vehicle traffic along roads contribute numerous chemicals to the environment including heavy metals, organic molecules (e.g. hydrocarbons), ozone and nutrients. De-icing salts are also a problem in colder climates (Trombulak and Frissell 2000). Water runoff from road surfaces may enhance growth of nearby vegetation or erode soils from roadsides and stream crossings. Most chemical transport occurs via stormwater runoff through and over the soil and from drainage into nearby water bodies. Pollutants may alter soil chemistry, be absorbed by plants and affect stream ecosystems (Forman and Alexander 1998). Roads also facilitate the dispersal of introduced plants and animals via three mechanisms: providing habitat by altering the natural conditions, making invasion more likely by stressing or removing native species and allowing easier movement by natural and human vectors (Trombulak and Frissell 2000).

Barrier and Fragmentation Effects

Forman (1995) considers that wide multilane highways, such as freeways, have the greatest ecological effect of all roads, as they remove more habitat and create more substantial barriers, effectively fragmenting the landscape and habitats they traverse. Landscape fragmentation with its associated loss and modification of habitat has been recognised as the greatest threat to biological diversity in Australia (Biological Diversity Advisory Committee 1992). Fragmentation not only reduces the quantity of habitat available for native plants and animals, but also reduces the suitability of the habitat that remains. Increased isolation of habitat patches may impede the movement of animals between patches and lead to local extinction of species (Haila *et al.* 1993). Fragmentation increases the ratio of edge to interior habitat, encouraging invasion by weeds (Scougall *et al.* 1993) and potentially increasing predation on birds and mammals (Andrén and Angelstram 1988; Burbidge and McKenzie 1989). Habitat fragmentation can also affect the reproductive success and probability of persistence of native plant species, by changing the plant's physical environment and its interactions with pollinators (Cunningham 2000).

Roads contribute to the fragmentation of habitat and the disruption of resident populations of plants and animals in a number of ways. A new road creates a physical barrier which splits patches of habitat into smaller, disjunct areas. Animals attempting to cross the road may be killed by collision with vehicles. In general, mortality increases with increasing traffic volumes (Rosen and Lowe 1994; Fahrig *et al.* 1995). The presence of a road may also modify an animal's behaviour. Species that are sensitive to noise and human disturbance will change their movement patterns and home ranges to avoid roads (Trombulak and Frissell 2000, and references therein). This avoidance of areas near roads further reduces the amount of habitat that is suitable for sensitive species in fragmented landscapes. The impacts of habitat fragmentation may be accelerated when local extinctions occur in important habitat patches as a result of increased mortality or a reduced probability of recolonisation associated with roads (Trombulak and Frissell 2000).

Noise

Research in the Netherlands has shown that noise from traffic severely disrupts the behaviour of grassland birds, causing them to move away from roads and to cease breeding. Depending on the species, roads with a traffic volume of 50,000 vehicles per day disturbed grassland birds up to 3530 m away (Reijnen *et al.* 1996; van der Zande *et al.* 1980). Reijnen *et al.* (1996) also found that populations of grassland birds were reduced by between 12% and 52% within 500 m of roads with a traffic volume of 50,000 vehicles per day. It is reasonable to assume that other animals will also be displaced by noise and disturbance created by roads.

The Existence of a Road Effect Zone

The ecological impacts of a freeway are not confined to the area immediately adjacent to the road. Ecologists throughout the world now recognise the existence of a 'road effect zone' (see *Conservation Biology* Vol. **14**, No. 1, 2000). Forman *et al.* (1995) describe a road effect zone as an area defined by the ecological effects extending from a road into the surrounding landscape. It is an area many times wider than the road surface and the roadside verge (Forman and Deblinger 2000).

The area impacted by the ecological effects of a road varies with the nature of the effect, quality of existing habitat, topography of the landscape and the prevailing wind direction. The road effect zone has convoluted boundaries and is highly asymmetric, due to the differential influences of environmental flows such as wind and water, and variation in habitats on opposite sides of the road (Forman and Deblinger 2000). Generally, it is larger down slope and downwind of the road, and in areas of higher quality vegetation or habitat (Forman 1999; Forman and Alexander 1998; Forman and Deblinger 1998). At points where a road crosses ecological conduits, such as streams, the road effect zone may extend much further outward. For example, particulate or heavy metal pollution from a road may extend for many kilometres downstream of a bridge, but a much shorter distance upstream or into adjacent terrestrial ecosystems (Forman 1999).

Quantification of a Road Effect Zone: The Hume Freeway F2 Link

The Hume Freeway F2 Link, or F2 Freeway as it is also known, is a freeway planned to connect the Hume Freeway at Craigieburn to the Northern Ring Road at Thomastown. A reservation for the connection was initially created along the valley of the Merri Creek, a northern tributary of the Yarra River, in 1975. Since then studies have shown that the freeway reservation traverses the 400 ha Craigieburn Grasslands and the 70 ha Cooper Street Grasslands which are now recognised as being of National and State significance for biodiversity conservation respectively (Gibson *et al.* 1999). The Grasslands provide habitat for a number of Nationally and State listed endangered species. Significant flora include Curly Sedge *Carex tasmanica*, Mat Flax-lily *Dianella amoena* and Swollen Swamp Wallaby-grass *Amphibromus pithogastris* while the endangered fauna include the birds Plains-wanderer *Pedionomus torquatus*, and Swift Parrot *Lathamus discolor* and the Striped Legless Lizard *Delmar impar* (Muir *et al.* 1998). Both grasslands have also been listed on the Register of the National Estate under the *Australian Heritage Commission Act 1975* (Gibson *et al.* 1999).

Recognition of the significance of the grasslands and presence of endangered flora and fauna has led to a number of alternative routes being proposed by VicRoads (1998). Public submissions on these routes were evaluated by an advisory committee appointed by the State Government against a defined set of objectives whose final recommendation (Gibson *et al.* 1999) was VicRoads' route 5 (1998). In the process of preparing advice for the Minister of Planning, the Department of Infrastructure (DOI) reviewed the Planning Assessment (VicRoads 1998) and Advisory Committee Reports (Gibson *et al.* 1999). The DOI determined that it was not happy that any of the seven options evaluated by the advisory committee provided a 'satisfactory combination of transport, economic and environmental outcomes' and convened a working group that developed a further set of route options labelled X, Y and Z (Department of Infrastructure 2000).

The Hume Freeway Advisory Committee Report (Gibson *et al.* 1999) stated that there was no evidence produced to indicate that the potential impact of noise on fauna within the grasslands was an issue of any real concern (p. 190). This indicates that recent research from around the world into the ecological impact of roads and the road effect zone may not be well known to consultants, planners and government agencies. The Working Party report (Department of Infrastructure 2000) also failed to consider the extent of the road effect zones on the values of grassland in the Merri Creek Valley primarily considering the direct impacts of freeway construction. As a public submission on the Working Party report (Department of Infrastructure 2000), the Australian Research Centre for Urban Ecology conducted an analysis of the potential road effect zone of the existing Hume Highway and the proposed routes 5, X, Y and Z. The results of this research are presented below.

Methods

We quantified the area of grassland affected by the proposed Hume Freeway F2 Link using Geographic Information System (GIS) modelling. Maps of the route options and areas of native grassland were provided by the Merri Creek Management Committee. The amount of grassland in the road effect zones was calculated for each route option to estimate the total habitat affected by road noise and pollution. The distance used for the zones was based on an estimated 35,000-40,000 vehicles per day predicted by traffic modelling to use the Hume Freeway Link Options 1 to 5 (Gibson *et al.* 1999). The routes used to produce these projections have slightly different alignments to those of the current proposal; however, traffic modelling projections for routes X, Y, and Z were not available.

Forman and Deblinger (1998) describe the calculation of road effect zones based on effect distances from research in the Netherlands on noise sensitive grassland birds (Reijnen *et al.* 1996). Forman and Deblinger (1998) used 810 m for 50,000 vehicles/day in natural ecosystems in urban areas. We were unable to obtain information on the effect of road noise on grassland birds in Australia so we have followed the example of Forman and Deblinger (1998) and used data from temperate grasslands in the Netherlands. However, we adopted a conservative 'road effect zone' of 750 m for each route option due to traffic volumes estimated to be less than 50,000 vehicles per day reported in the Dutch study. The Hume Highway was also given a road effect zone of 750 m when considered in combination with any of the Hume Freeway Link options. The road effect zone of an upgraded existing Hume Highway was estimated to be 1 km, as the projected traffic volume on an upgraded Hume Highway is estimated to be 64,000 vehicles per day (Gibson *et al.* 1999). The area of the road effect zone does not include the added effect of the upgrading of the east-west roads in the area, such as Cooper Street and Craigieburn Road East, to four lanes. This would further fragment the landscape and reduce the area of core habitat available for many species.

The road effect zone is more complex than simply affected and non-affected areas. There will be a decline in intensity of road effects with increasing distance from the road, and the distance and significance of the effects will vary depending on the organism examined. We used grassland birds to illustrate the potential area of grassland affected by the Hume Freeway F2 Link because they have been shown to be sensitive to noise originating from roads.

Results

Our results indicate the road effect zone of all options for the Hume Freeway F2 Link will fragment the grasslands of the Merri Creek Valley and reduce the quality of grassland habitat. Route Options 5, X, Y and Z are presented in Fig. 1. The impact of the road effect zones on the adjacent native grasslands is presented in Table 1. Upgrading the existing Hume Highway will have the least impact by placing the smallest amount of grassland in the road effect zone (151 ha) (Fig. 2) and potentially impacting only 13% of the existing grasslands. This option actually includes very little additional grassland in the road effect zone that is not already impacted by the existing Hume Highway road effect zone.

Option 5 potentially impacts 461 ha of native grassland, most of which is in the Craigieburn East Grassland which it bisects. Option X would have the greatest impact, placing 645 ha of grassland in the road effect zone (Fig. 3) and affecting 55% of the existing grasslands. It also crosses Merri Creek three times, significantly increasing the impact of the freeway because the road effect zone is wider at water crossings (Forman 1999). Option Y impacts 285 ha of grassland habitat and creates a barrier between the Craigieburn and Craigieburn East Grasslands while the road effect zone of Option Z is 427 ha. Option Z also crosses Merri Creek in three places. The road effect zone of Options X and Z encompass all of the Cooper Street and Galada Tamboore Grasslands. Option 5 and Option Y create road effect zones that completely engulf Galada Tamboore. These areas would effectively become unsuitable habitat for grassland birds. The area of grassland included in the road effect zone for each option is dependent on the width of the zone. Fig. 4 illustrates the area of native grassland remaining unaffected by road impacts with varying road effect zone width for each option.

Discussion

Many of the new and proposed freeways to the west and north of Melbourne traverse areas that contain remnant native grassland. Lowland temperate grasslands are among the most endangered ecosystems in Australia (Lunt 1994), and Western (Basalt) Plains Grassland which occurs in western and northern Melbourne is one of the most endangered vegetation communities in Victoria (Stuwe 1986; Frood and Calder 1987). It is listed as a threatened community on Schedule 2 of the *Flora and Fauna Guarantee Act 1988*, and is the subject of a Department of Natural Resources and Environment Action Statement (Muir 1994).

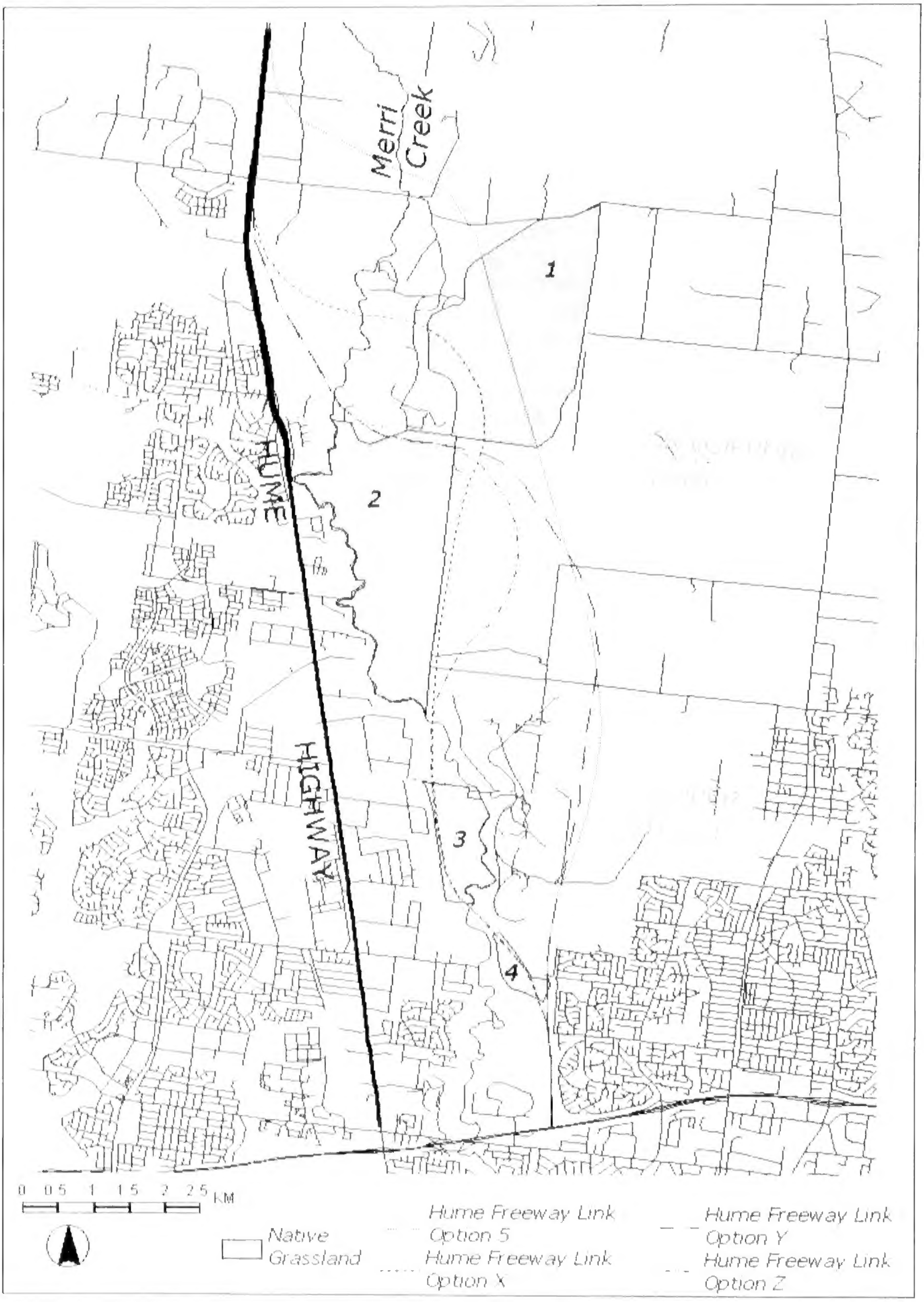

Fig. 1. The Hume Highway, and the different route options for the Hume Freeway F2 Link. Native grassland Reserves 1. Craigieburn East, 2. Craigieburn, 3. Cooper Street and 4. Galada Tamboore.

Freeway construction has had significant, direct impacts on native grassland in the Melbourne region. The construction of the Western Ring Road destroyed many native grasslands. Substantial areas on the northern boundary of Derrimut Grassland Reserve and at the Sunshine Tip Grasslands that were of State significance

Table 1. The potential impact of the proposed Hume Freeway F2 Link on grasslands based on an estimated road effect zone of 750 m.

Route	Area of grassland in the 'road effect zone' (ha)	% of existing grassland habitat impacted by 'road effect zone'	Comments
Option 5	461	39	Craigieburn East Grassland split in half, Galada Tamboore lost
Option X	645	55	Largest area of grassland impacted by road effect zone
Option Y	285	24	Second smallest area of grassland impacted by road effect zone, Galada Tamboore totally included in road effect zone
Option Z	427	37	Two reserves totally included in 'road effect zone'
Upgrade of Existing Hume Highway	151	13	Only one reserve impacted by road effect zone, no grassland lost through road construction, no further fragmentation of grassland patches

were removed as were many smaller patches along the alignment (Meredith *et al.* 1989). Many of the route options for the proposed Hume Freeway F2 Link will cut through native grasslands of National and State significance to flora and fauna, including the Craigieburn and Cooper Street Grasslands that are listed on the register of the National Estate (Department of Infrastructure 2000; Muir *et al.* 1998; Muir *et al.* 2000).

Up to 52 ha of significant native grassland will be removed by the construction of the Hume Freeway F2 Link (Muir *et al.* 2000). Our analysis has indicated that many times this amount may potentially be influenced by the indirect impacts of the freeway. The area of native grassland within the road effect zone ranges from between 285 ha for Route Y to 645 ha for Route X. To date, little scientific research has been conducted on the indirect impact of roads on native grassland in Australia. Some studies have identified the expected effects of freeway projects on grasslands: permanent loss of remnant vegetation, permanent changes to the hydrological regime and increased potential for invasion by environmental weeds have been listed (Department of Infrastructure 2000; Meredith *et al.* 1989) but no one has sought to quantify them.

Morgan (1998) investigated the influence of a roadside edge as part of a larger study analysing weed invasion in an urban grassland at Evans Street, Sunbury. He found that vegetation located on the roadside edge of the remnant was significantly different floristically to vegetation in the centre of the reserve as well as the remnant edge bordering a railway line. Introduced plant species richness was significantly higher and richness and cover of native species was significantly lower at the remnant edge bordering the roadside than at all locations within the remnant. Soil nutrient analysis revealed that non-native species were favoured by higher concentrations of phosphorous and ammonium which were higher on the roadside edge of the remnant. Nitrate was also found to favour non-native species but was not found to be correlated with the roadside edge. Increased soil phosphorous and weed invasion did not extend beyond 10 m from the road edge into the grassland.

Higher nutrient concentrations and changes in plant species composition along the roadside edge at Evans Street Grassland cannot be solely attributed to the presence of a road as other influences such as nutrient input from dogs and occasional garden waste dumping may also be important (John Morgan *pers. comm.*). However, some contribution from traffic should be expected as vehicle emissions, such as carbon dioxide, sulphur dioxide and oxides of nitrogen, are known to act as fertilisers or affect plant growth (Angold 1997). Angold (1997) found that trends in the species

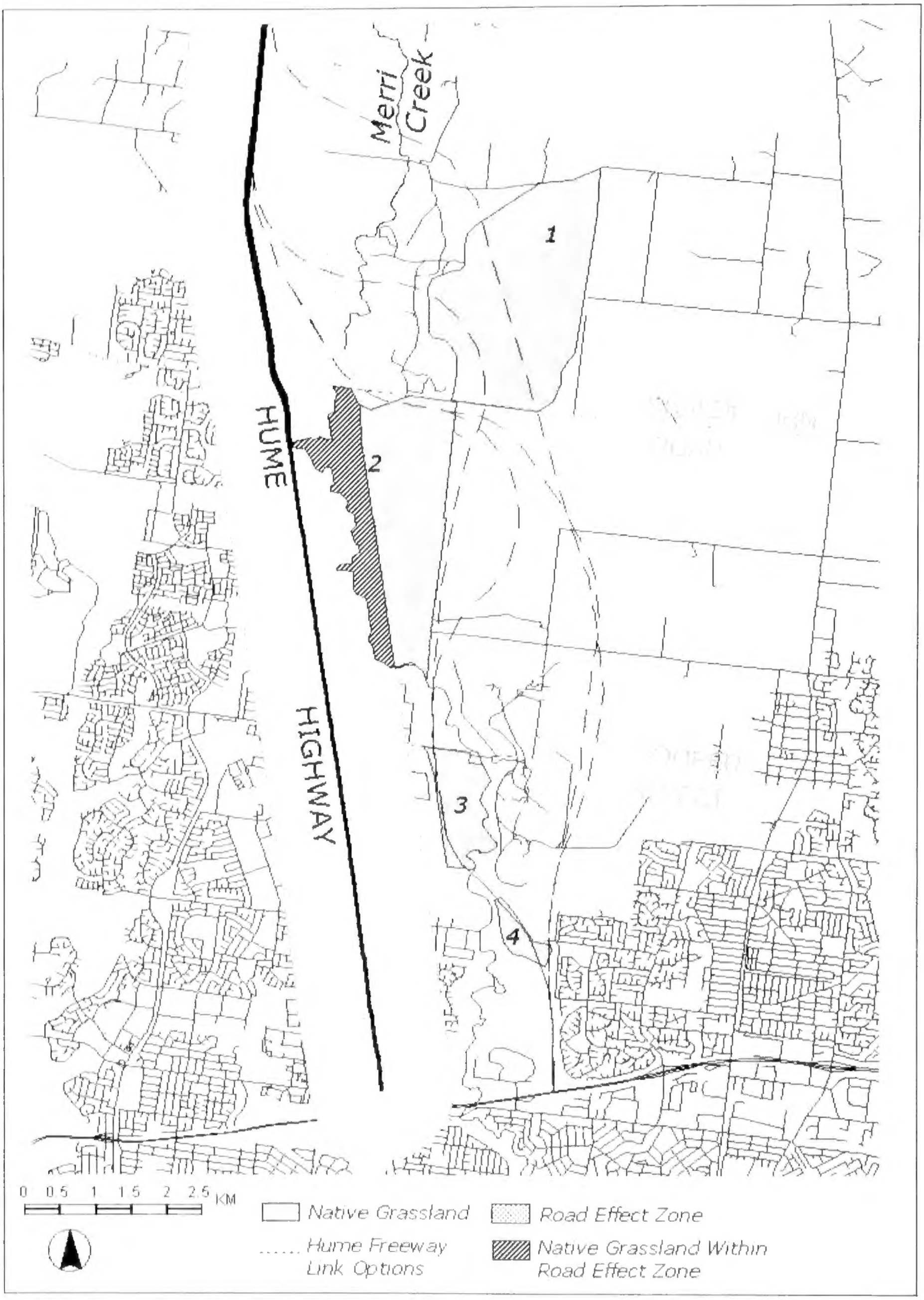

Fig. 2. Upgraded Hume Highway, with a 1 kilometre road effect zone. Affected areas of native grassland are shown with diagonal lines. Native grassland Reserves – 1. Craigieburn East, 2. Craigieburn, 3. Cooper Street and 4. Galada Tamboore.

composition and enhanced growth of heathland vegetation, adjacent to a four lane highway in Britain, were significantly correlated with distance from the road and that the effect extended up to 200 m each side of the highway. This was attributed to

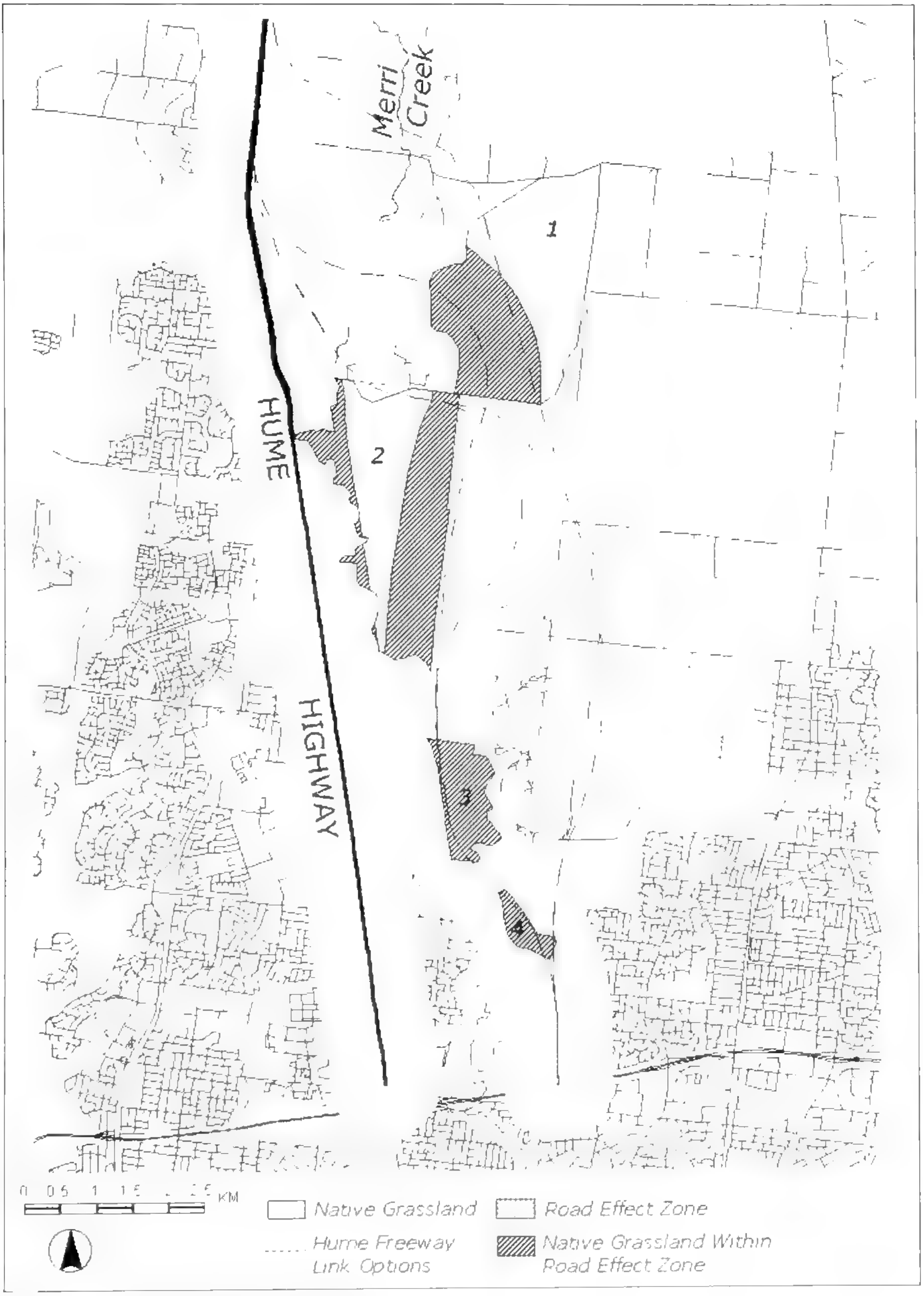

Fig. 3. Existing Hume Highway and Hume Freeway F2 Link Option X, with 750 metre road effect zone. Affected areas of native grassland are shown with diagonal lines. Native grassland Reserves 1. Craigieburn East, 2. Craigieburn, 3. Cooper Street and 4. Galada Tamboore.

eutrophication from oxides of nitrogen emitted by vehicle exhausts. Similar effects and distances could be expected for grasslands bordering freeways in Australia.

Grasslands in the Melbourne region provide important habitat for populations of

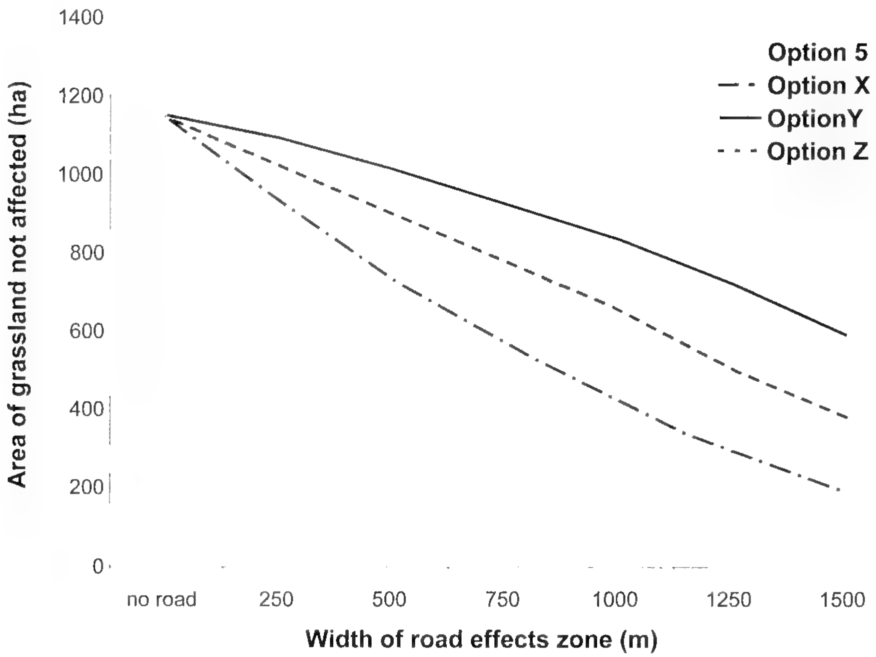

Fig. 4. The area of native grassland not impacted by the road effect zone with varying width of the road effect zone for each Hume Freeway F2 Link option.

many resident and migratory bird species. There are at least 20 grassland bird species recorded in the Melbourne area that are considered to be of conservation concern on either a regional, State or National level (Table 2) (Beardsell 1991; Beardsell 1997; Department of Natural Resources and Environment 2000). These include the nationally endangered Plains-wanderer *Pedionomus torquatus* and the Red-chested Button-quail *Turnix pyrrhothorax* which is listed as vulnerable in Victoria.

Table 2. Grassland bird species considered to be restricted (Res), rare (R), depleted (D), threatened (T), vulnerable (V) or endangered (E) for the Melbourne Region, Victoria and on a National level. Significance ratings have been obtained from Beardsell (1991; 1997) and Department of Natural Resources and Environment Victoria (2000).

Scientific Name	Common Name	Region	State	National
Accipiter cirrhocephalus	Collared Sparrowhawk	Res		
Calamanthus fuliginosus	Striated Fieldwren	D		
Cinclorhamphus mathewsi	Rufous Songlark	D		
Circus assimilis	Spotted Harrier	D		
Coturnix australia	Brown Quail	Res		
Falco peregrinus	Peregrine Falcon	Res		
Haliastur sphenurus	Whistling Kite	D		
Hieraaetus morphnoides	Little Eagle	Res		
Lathamus discolor	Swift Parrot	E	E	
Merops ornatus	Rainbow Bee-eater	D		
Milvus migrans	Black Kite	T		
Ocyphaps lophotes	Crested Pigeon	R		
Pedionomus torquatus	Plains-wanderer	E	E	D
Poephila guttata	Zebra Finch	D		
Stagonopleura guttta	Diamond Firetail	D		
Turnix pyrrhothorax	Red-chested Button-quail	E	D	
Turnix varia	Painted Button-quail	Res		
Turnix velox	Little Button-Quail	T		

A large body of Australian and international research has demonstrated that many birds that breed in grasslands require large habitat patches (Vickery *et al.* 1994; Herkert 1994; Baker-Gabb *et al.* 1990). Patches shaped to provide abundant interior areas, free from the impact of edges, have also been shown to maximise bird species richness. For example Red-chested Button-quail require patches of suitable habitat larger than 50 ha (Beardsell 1997), while areas favoured by the Plains-wanderer are approximately 200 ha (Baker-Gabb *et al.* 1990). Experts suggest that the conservation of the Plains-wanderer in north-east Melbourne will require the retention and management of the remaining patches of grassland. In addition, they recommend the linking of suitable native grassland habitat (Beardsell 1997). Given the ecological requirements of the species it is evident that a reserve supporting viable populations must be large (Beardsell 1997).

Freeways may also hinder or prevent the appropriate management of native grasslands. Western Basalt Plains Grassland requires burning at intervals not greater than 3 years to maintain native plant diversity and vigour (Lunt 1994; Morgan and Lunt 1999). However, it is difficult to achieve this aim for grasslands bordered by freeways as smoke may be a hazard to motorists. Bainbridge and Bush (2000) describe the complexity of conducting prescribed burns in urban areas while Lunt (1994) has identified the cultural, operational and financial difficulties of burning grasslands for conservation purposes. For Parks Victoria to burn the Laverton North Grassland Reserve wind must blow smoke away from a neighbouring petrochemical industrial plant and over the Princes Freeway. Consequently, burns must take place at night and require the employment of a traffic management group to close the freeway down to one lane that travels at 60 km/h. This dramatically limits the window of opportunity available to burn the reserve and as a result burns may be delayed until the following year (Fiona Smith, Parks Victoria Ranger in Charge, Melbourne Grasslands, *pers. comm.*).

Conclusion

Roads have both direct and indirect impacts on the environments they traverse. Apart from the direct removal of biota and the reduction and fragmentation of adjacent habitats, all roads contribute pollution, noise and exotic organisms to the surrounding ecosystem in a zone of variable width either side of the road. The existence of a road effect zone suggests that reserves may not fully protect the biological values of natural ecosystems if those reserves are in close proximity to freeways. This may be particularly true for native grasslands that require regular, active management and provide habitat for organisms susceptible to noise and other impacts of roads.

The two largest protected areas of native grassland in Melbourne, the Derrimut Grassland Reserve and the Laverton North Grassland Reserve, are both bordered by freeways. It is also proposed that the newly proclaimed Craigieburn Grasslands Flora and Fauna Reserve will be bordered by the Hume Freeway F2 Link to some degree. The road effect zone of the proposed route options for the Hume Freeway F2 Link would result in significant areas of the grasslands of the Merri Creek Valley being affected by noise, increased nutrients and other impacts of the freeway. This will further fragment the grasslands of the Merri Creek Valley and substantially reduce the area of suitable habitat available for grassland birds. In the past the indirect impacts of roads, highlighted by the road effect zone, have not been considered in the transportation planning process. Successful management and mitigation of all the environmental impacts of road projects dictates that the road effect zone should be considered. To facilitate this there is a need for research to quantify the nature and extent of the impacts of roads and freeways on Australian ecosystems.

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Editor's note: An interesting general article on the 'road effect zone' (REZ) appeared in *New Scientist*, 3 February 2001. Christie Aschwanden, in 'Tread Softly' on pp. 32-36, describes the theory of REZs and how disruption to the environment by road networks can be lessened.

One Hundred Years Ago

'A report of the dredging excursion on Saturday, 15th December, was read by the leader, Mr. J. Gabriel, who said that the Club was indebted to Mr. C.J. Cottell for the use of the yacht *Starlight* on the occasion. A start was made from the North Brighton pier at about 2.30 p.m., eleven members being present. The afternoon proved a very pleasant one, but, owing to the light wind, results were scarcely so good as had been expected, as time did not permit of the boat reaching the most favourable collecting grounds. Two dredges were employed, and a fair number of Mollusca, Crustaceans, and other forms of marine life were obtained. Amongst the shells found the most notable were *Meretria lamarcki* and *Cardita gunnii*, which were dredged, living, in fair quantities off Brighton Beach. Of the higher Crustaceans obtained *Ebalia (Phlyxia) intermedia*, Miers, and *Hymenosoma rostratum*, Haswell, are worthy of mention, as these forms are not included amongst our common littoral species.'

Excursion To Frankston

'Striking across the recreation ground towards Mt. Eliza the whole country was found to be a perfect flower garden, in which *Leptospermum scoparium* and *Ricinocarpus pinifolius* were conspicuous by their dazzling white flowers, while *Melaleuca squarrosa* scented the air with its rich honey-like perfume. A few insects of the commoner kinds were obtained by shaking. Crossing over some low-lying ground towards the cemetery the pretty *Utricularia dichotoma*, *Candollea calcaratum*, *Comesperma ericinum*, and other plants were seen at their best. Many years ago the beautiful pink orchid *Spiranthes australis* was to be found in this locality, but improvements have resulted in its disappearance. The singular plant *Drosera binata* grows here-abouts, along with that curious fern *Schizea fistulosa*. *Polypompholyx tenella*, *Sebaea albidiflora*, *Drosera pygmaea*, and *D. glanduligera* grew in abundance wherever there was permanent moisture. A few buprestid beetles, of which *Stigmodera maculata* and *S. xanthipilosa* were the most common, were taken, while some half-dead leaves of a eucalyptus, shaken into the umbrella, yielded several specimens of the pretty longicorn, *Ectosticta cleroides*. The little green beetle *Diphucephala rugosa* was very plentiful on the scrub. Very few orchids were seen, but the little plant *Comepserma calymega* reminded us that summer was rapidly approaching.'

From *The Victorian Naturalist* Vol. **XVII** - No. 10, February 7, 1901

Buxton Silver Gum Reserve: Using Geographic Information Systems to Investigate Historic Change in Site Integrity

Dianne Simmons[1], Robyn Adams[1] and Chris Lewis[1]

Abstract
Eucalyptus crenulata is a rare species known from only two populations. The Buxton Silver Gum Reserve was set aside in 1978 for the conservation of the species, but this objective may be compromised by changes in the integrity of the landscape immediately surrounding the Reserve. A time sequence of aerial photos and Geographic Information Systems technology has been used to identify patterns of landscape change, and aid in determining appropriate management strategies to minimize negative impacts caused by landscape fragmentation and habitat exposure. (*The Victorian Naturalist* **118** (1), 2001, 16-20.)

Introduction

Buxton Gum *Eucalyptus crenulata* Blakely & Beuz. is a rare and distinctive species with glaucous, crenulate heart-shaped leaves (see photo front cover). *Eucalyptus crenulata* is regarded as Vulnerable in Victoria (Gullan *et al.* 1990) and Vulnerable in Australia (Briggs and Leigh 1988). *Eucalyptus crenulata* is a relict species, having had a more extensive distribution in long-past wetter and colder periods. It is now found at only two sites in Victoria (Pryor 1981), and the suggestion that the species distribution has contracted in historic times due to European disturbance (Pryor 1981; Albrecht 1983; Jelinek 1991) is largely speculation. Due to the species' habitat specificity, it is more likely that at the time of European settlement, it existed as only two populations in two rare, isolated habitats embedded in a matrix of other native vegetation.

The species is confined to a specific and uncommon habitat (Pryor 1981; Prober and Austin 1990), and the habitat peculiarity of the two extant sites may be indicated by other rare species still found growing in association with *E. crenulata*. At the Yering site the rare *Pomaderris vacciniifolia* and *Pimelea pauciflora* are also present (McMahon *et al.* 1989), and there are a number of restricted species such as *Sphagnum cristata* and *Gymnoschoenus sphaerocephalus* at Buxton (Jelinek 1993). The site at Buxton may now represent a rare community rather than just a site with a single rare species.

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The Yering site (145° 21'E, 37° 41'S) adjacent to the Yarra River, has been cleared for well over a century and the hydrology has been extensively modified. Only a few trees of *E. crenulata* remain although there are a large number of hybrids (Simmons 1970; Jelinek 1991). Intensive management of this site is required if the natural population is to be restored and conserved. In contrast, the site at Buxton (145° 41'E, 37° 27'S), reserved in 1978 when the Buxton Silver Gum Reserve was established (Jelinek 1991), has a different landscape context, and potentially a very different management requirement. The site appears to be relatively intact, with few weeds, an uncommon combination of understorey species, and it contains a healthy *E. crenulata* population of approximately 600 adult trees (Adams and Simmons 2000).

Eucalyptus crenulata is easily propagated, and as a species it is not threatened with extinction. Past hybridization between *E. crenulata* and *E. ovata* at Yering has resulted in few trees which produce seedlings clearly assignable to *E. crenulata*, and which lack evidence of hybrization (Simmons 1970; Simmons and Parsons 1976; C. Fletcher 2000 *pers. comm.*). Conservation of the site at Buxton is particularly important as a seed source as the genetic resources of the species are still intact.

The Buxton population of *E. crenulata* is in an apparently secure Reserve. However, the viability of species and populations in reserves is affected by their landscape con-

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text, and by activities adjacent to the site. The isolation of fragments caused by land clearance often leads indirectly to habitat degradation due to the changed physical circumstances of the remnant (Saunders *et al.* 1991; McIntyre and Hobbs 1999). Thus reservation of significant habitat alone may not be sufficient to provide future protection for a species.

The interpretation of aerial photos can provide a history of landscape change (Hobbs *et al.* 1992), and mapping of landscape at different times can provide a good indication of landscape fragmentation and change (Worth 1996), and clarify fragmentation processes and their potential impacts on species conservation (Zheng *et al.* 1997). Geographic Information Systems (GIS) are a useful tool for monitoring changes identified in aerial photos, as they allow display at a range of scales, with the capacity to magnify areas of interest such as boundaries, and to readily calculate indices of landscape pattern and fragmentation (Simpson *et al.* 1994; Mast *et al.* 1997; Bruce *et al.* 1998) such as core areas or perimeter to area ratios.

Understanding the historic landscape context of a remnant, in this case the Buxton Silver Gum Reserve, can aid in determining the type of conservation management suitable for a particular remnant in a particular landscape context (McIntyre and Hobbs 1999). This study identified changes in land cover adjacent to the Buxton Silver Gum Reserve using historic aerial photos and Geographic Information Systems (GIS) technology, and used the pattern of landscape change detected to suggest appropriate management strategies.

Methods

Land cover mapping was carried out using unrectified black and white aerial photos. Sequential aerial photos were obtained for 1952, 1960, 1971 and 1987 (with nominal scales approximately 1:14,000). No more recent photographs of suitable scale are available. All photographs were digitized, georeferenced using GeoSmartimage® software, and then imported into ArcView 3.2® GIS software (ESRI 1996). Land cover classes were interpreted and digitized by a single operator for an area covering approximately 200 ha (one aerial photograph) immediately surrounding the Buxton Silver Gum Reserve. Vegetation was mapped as 'tree cover' versus 'no tree cover' as further distinctions between different vegetation types could not be reliably assessed (Mast *et al.* 1997). The present distribution of *E. crenulata* was also mapped from aerial photos and ground survey.

Results

Land cover maps showing the areas with tree cover/no tree cover and the present distribution of *E. crenulata* were produced (Fig. 1) and clearly indicate the loss of tree cover, and the increasing isolation of *E. crenulata* habitat over 35 years. In 1952 and 1960 tree cover was almost continuous, covering most (90%) of the study area, and surrounding most of the *E. crenulata* habitat. By 1987, less than half the study area had tree cover (45%) (Fig. 2a), and visual inspection of the area suggests that the land cover in 2000 is little altered from the 1987 situation.

The length of the perimeter bounding the *E. crenulata* site and the adjacent cleared areas also increased from only 150 m in 1952 to 575 m by 1987 (Fig. 2b).

Significant fragmentation of the treed area has occurred, increasing from one treed area (90%) and one cleared area (10%) in 1952 to seven fragments by 1987 (Fig. 1). Five of these fragments are less than 1 ha in area. The remaining two 'fragments' are actually part of larger areas of forest which continue beyond the arbitrary boundary of the study area; the larger of these surrounds the site on the northern and western perimeter, and the other is approximately 800 m to the east. Nine trees have been isolated in a small fragment on private land on the northern edge of the Reserve, but no reduction in area or decrease in tree cover of the actual *E. crenulata* population within the Reserve was detected.

Discussion

Habitat destruction is the loss of structural and floristic features of the original vegetation (McIntyre and Hobbs 1999), and can be expressed simply by differentiating between those areas with tree cover and those areas with no tree cover. The historic

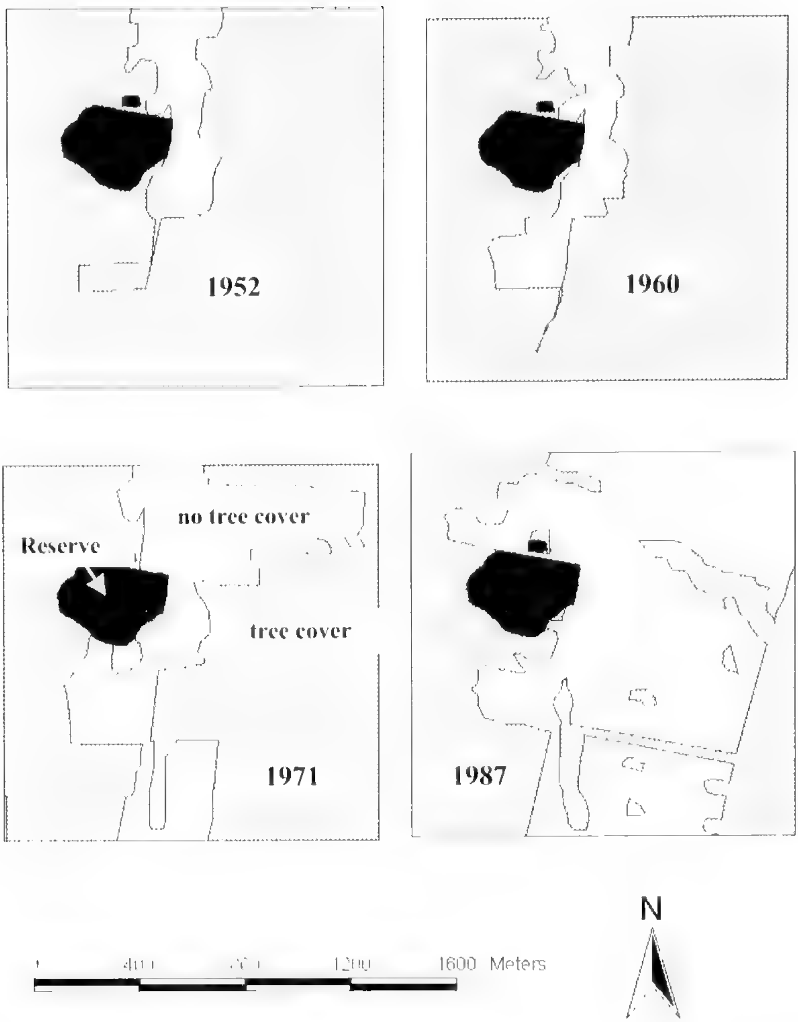

Fig. 1. Changes in land cover category from tree cover to no tree cover for the area surrounding the Buxton Silver Gum Reserve, between 1952 and 1987.

sequence of land cover maps showed no detectable reduction in the area occupied by *E. crenulata*.

However, for the area surrounding the Buxton Silver Gum Reserve they clearly indicate loss of tree cover, significant fragmentation of the original treed area, and increasing isolation of *E. crenulata* habitat. McIntyre and Hobbs (1999) suggest that the threshold for a shift to a 'fragmented' landscape occurs when habitat retention (tree cover) is less than 60%. In the area immediately surrounding *E. crenulata*, retention of tree cover is now much less (45%) than this threshold. Many ecosystem processes can be disrupted when habitat becomes isolated and the remaining fragments are embedded in a matrix of cleared land (Saunders *et al*. 1991). Among the potential threats to the internal integrity of *E. crenulata* habitat, are fungal attack (*Phythophthora cinnamomi* has been detected in soil in the Reserve), Coarse Dodder-laurel *Cassytha melantha* infestation (41% of trees are infested), weed invasion, and lack of recruitment.

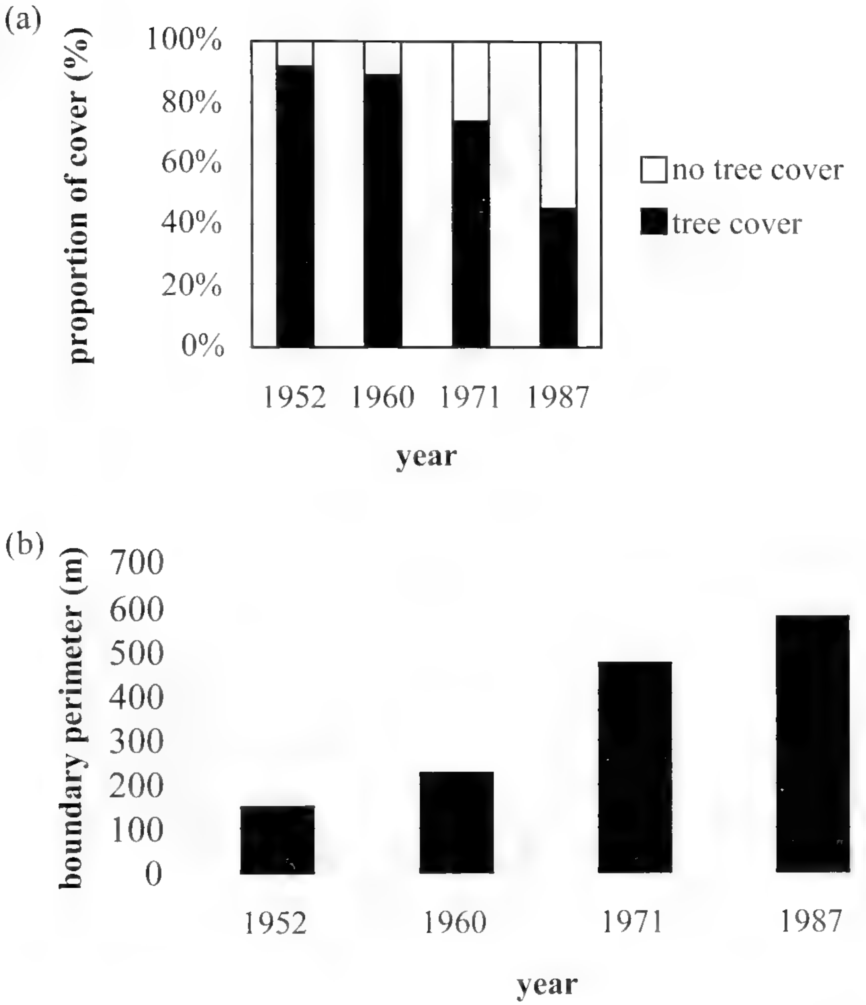

Fig. 2. Changes in (a) the proportion of the study area covered by trees (% of 200 ha) and (b) boundary perimeter (m) exposed to adjacent cleared areas, between 1952 and 1987.

There are about 600 adult trees at the site, but few seedlings of *E. crenulata* are present and the population is skewed to smaller size classes with few large trees (Adams and Simmons 2000).

Although there has been a large increase in the length of perimeter of the *E. crenulata* habitat exposed to cleared areas, about 60% of the site perimeter is still adjacent to treed areas. However, the simple binary division between tree cover and no tree cover may underestimate the disturbances impacting on the Reserve (McIntyre and Hobbs 1999). Adjacent areas of habitat mapped as tree cover may have been significantly modified. Some of the adjacent large areas of forest have been logged, and the Buxton Silver Gum Reserve now forms part of a variegated landscape (McIntyre and Hobbs 1999) comprising treed areas with various degrees of modification through to completely cleared areas. The degree of exposure of the Buxton Silver Gum Reserve may greatly increase the likelihood of negative impacts on the ecological functioning of the *E. crenulata* population.

From a management perspective, using aerial photos and GIS capabilities to examine the landscape changes in the area surrounding the Buxton Silver Gum Reserve, has allowed the identification of a trend towards increasing isolation and exposure of the site to the physical changes, such as wind and light regimes, associated with fragmentation (Saunders *et al.* 1991). While investigation of the ecology of *E. crenulata* continues (Adams and Simmons 2000), one immediate and potentially highly effective management action is to decrease the exposure of the site by restoring a vegetated buffer to reduce the abrupt boundary interface between the *E. crenulata* population and the cleared areas. However, most clearing has occurred on private land and the opportunities to reduce isolation of the Buxton Silver Gum Reserve are limited without participation and involvement of adjacent landholders.

Like *E. crenulata*, a number of other *Eucalyptus* species are known to be restricted to unique habitats (Prober and Austin 1990). However, reservation of the habitat alone may not be sufficient to provide protection for a rare community or a rare species because of potential climatic changes (Prober and Austin 1990) or changes to the landscape context and land-use adjacent to the habitat (Saunders *et al.* 1991; McIntyre and Hobbs 1999). Rare habitat may need to be surrounded by a matrix of other vegetation in order to be buffered from the altered physical processes which accompany fragmentation (Saunders *et al.* 1991). Even common species can become threatened by the accumulation over time of small, individual changes to landscape integrity (Worth 1996). *Eucalyptus crenulata* at the Buxton Silver Gum Reserve provides an example of the how the use of aerial photography and GIS technology can be combined to identify fragmentation processes and their potential impacts, and aid in suggesting appropriate management strategies for the conservation of other restricted species.

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Yarrow *Achillea millefolium* L.: a Weed Threat to the Flora of the Australian Alps

Frances Johnston[1] and Catherine M. Pickering[1]

Abstract
Yarrow (Milfoil) *Achillea millefolium* L. is a potential threat to the native subalpine and alpine plant communities of the Australian Alps. Although Yarrow has been found in Kosciuszko National Park for the last 50 years, it has extensively colonised subalpine disturbed habitats, including roadways, during the last decade. Currently, isolated plants can be found in adjacent native vegetation, and a few plants have been found and removed from areas as high as 2000 m along the summit of the main range. Research is currently being conducted on the biology and control of this 'most hardy weed … well named for the invulnerable Achilles' (Georgia 1942). (*The Victorian Naturalist* **118** (1), 2001, 21-24.)

Yarrow *Achillea millefolium* L. (Asteraceae), is a drought tolerant perennial herb with rhizomatous vegetative growth (Fig. 1). It is native to Europe and Western Asia (Zhang *et al.* 1996). Aromatic pinnately dissected leaves are produced in a basal rosette and along the flowering stem. Both stems and leaves are covered with short, white, silky hairs. The flower heads are arranged in a corymbiform inflorescence, each head consisting of around 5 ray flowers (usually white, pink or magenta) and 20-25 disk flowers. Flowers are self-incompatible with an extended flowering period from spring to autumn. Achenes, produced in large numbers, are oblong, 1.5-2.0 mm long, and grey-white in colour (Rydberg 1916; Chandler *et al.* 1982; Warwick and Black 1982).

Yarrow grows throughout south-eastern Australia where it is often cultivated as a popular garden plant and lawn substitute (Thorton-Wood 1999). Although often sold in nurseries, it is regarded as an environmental weed in the Australian Capital Territory, New South Wales and Victoria (Anon 1998; Sainty *et al.* 1998; McDougall and Appleby 2000).

Throughout the Australian Alps, Yarrow grows along roadsides and around buildings (Costin 1954; McDougall 1982; Mallen-Cooper 1990; Sanecki 1999, Figs 2 and 3). Although recorded as early as 1949 in grasslands in the subalpine zone of Kosciuszko National Park (NSW Soil Conservation Herbarium database), populations of Yarrow appear to have increased rapidly in Kosciuszko National Park during the 1990s (R. Knutson, NSW National Parks and Wildlife Service, *pers. comm.*; Sanecki 1999). The increase in Yarrow is possibly associated with the use of gravel from weed-contaminated dumps in the construction of roads and other infrastructure (R. Knutson, NSW National Parks and Wildlife Service, *pers. comm.*). Recent surveys found Yarrow in all four zones (alpine, subalpine, montane and tableland) of Kosciuszko National Park, predominantly in highly disturbed sites. Potentially of most concern are isolated Yarrow plants that have recently (since 1998) been found in the alpine area along the old Summit Road and the Main Range walking track, as well as around Seamans Hut in the true alpine zone.

Where populations of Yarrow occur on road embankments, roadside drains and other disturbed sites (Fig. 4), our surveys indicate that isolated plants are often found in the adjacent native vegetation (Table 1). This indicates that Yarrow has the potential to spread from disturbed areas into native vegetation.

Achillea millefolium is potentially a serious threat to the vegetation communities of the high altitude areas of the Australian Alps. It has broad environmental tolerance, including a capacity to thrive on a range of soil types, and in a range of climates (from arid to alpine; Clausen *et al.* 1958; Bourdot 1984). It is a common weed in many temperate countries including most of North America, Canada, Russia, temperate Europe, New Zealand and Australia (Clausen *et al.* 1958; Bourdot 1984). When

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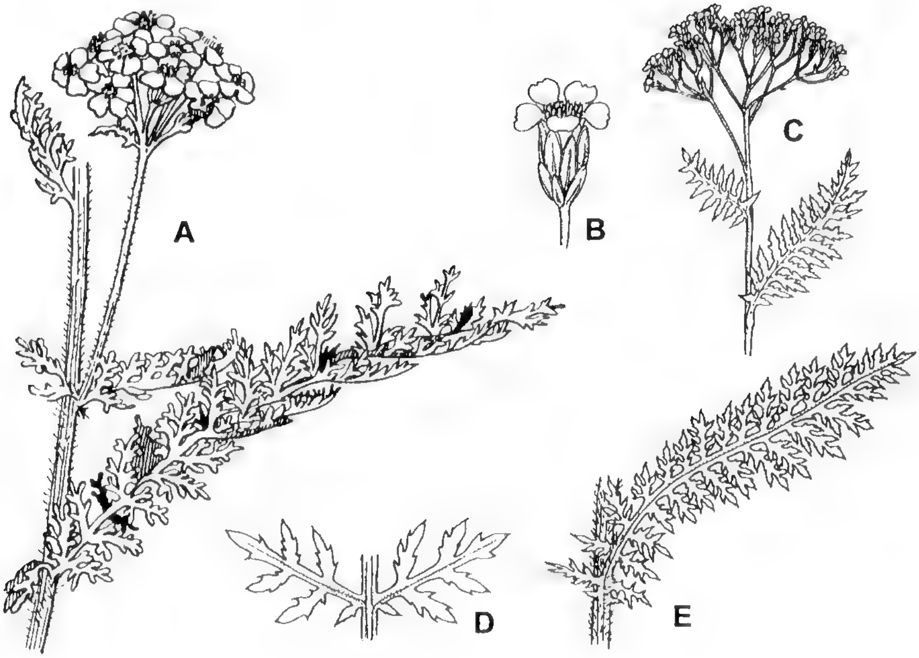

Fig. 1. Inflorescence and leaves of Yarrow *Achillea millefolium*. A. Lateral corymbiform inflorescence and cauline leaves. B. Individual head. C. Terminal branched corymbs. D. Leaflet. E. Cauline leaf. Modified from Stanley and Ross (1983, A), and Hardin (1992, B-E).

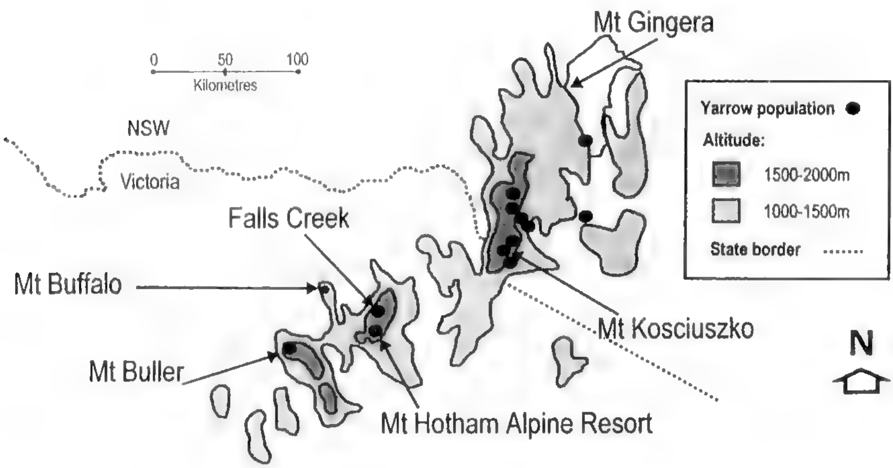

Fig. 2. Populations of Yarrow in the Australian Alps. Areas above 1000 m, 1500 m marked. Locations from Mallen-Cooper (1990), Sanecki (1999), McDougall and Appleby (2000) and present study. Map modified from Green (1994).

allowed to spread unchecked in the forests of Siberia, it forms an understorey monoculture (Banks, Australian National University, Canberra, *pers. comm.* 1999).

A series of attributes, including high seed production, rapid seedling growth, long-term seed dormancy, rhizomatous growth and strong competitive ability, contribute to Yarrow's invasive potential in high altitude areas (Henkens *et al.* 1992). Yarrow

Table 1. Recorded occurrences of Yarrow plants in native vegetation near populations growing along roadsides in Kosciuszko National Park.

Location	Latitude, Longitude	Altitude (m)	Distance to road (m)	Vegetation type
Geehi River Bridge	36°17', 148°18'	1400	5	Subalpine grassland
Dicky Cooper Creek	36°15', 148°21'	1860	6-15	Tall alpine herbfield
Orange Hut	36°16', 148°23'	1700	1	Subalpine grassland
Valentines Hut	36°16', 148°23'	1700	3	Subalpine open woodland
Shlinks Pass	36°15', 148°25'	1800	3	Subalpine heath
Guthega Power Station Gate	36°20', 148°25'	1600	3	Subalpine open woodland
Perisher Pass	36°24', 148°25'	1700	3, 8, 22, 28, 39	Subalpine grassland
Smiggins Hole Sewage Ponds	36°23', 148°26'	1700	40	Subalpine grassland
Seamans Hut	36°28', 148°16'	2000		Tall alpine herbfield
Twynam Ridge	36°35', 148°20'	2000		Tall alpine herbfield
Daners Gap	36°22', 148°28'	1700	30-40	Subalpine grassland

shows limited wind dispersal with most seed found within a few metres of the plant (Bourdot *et al.* 1979). However, contamination of gravel and mulch appear to have assisted its dispersal in Australia and overseas (Bourdot and Field 1988; R. Knutson NSW National Parks and Wildlife Service *pers. comm.*). Yarrow also has many of the characteristics of other rhizomatous weeds including bud dormancy, strong apical dominance broken by disturbance, and rapid vegetative propagule formation on fragmentation (Bourdot 1984); characteristics that facilitate the growth and spread of the plants in new habitats.

Studies in New Zealand on methods to control Yarrow indicate that both different herbicides (bromacil, terbacil, clopyralid, chlorsulfuron, phenoxy, triazine, urea, dinitroaniline, benazolin, bentazone and oxyfluorfen) and other control measures have limited success (Bourdot *et al.* 1982; Bourdot and Butler 1985; Field and Jayaweera 1985; Bourdot and Field 1988). Preliminary results from chemical trials on Brush-off (7 g/100 L), Banvel/Amicide (500 ml/100 L), Glyphosphate (1000 mL/100 L and Grazon (500 mL/100 L) conducted in subalpine areas of Kosciuszko National Park support these

Fig. 3. Frances Johnston assessing cover of Yarrow *Achillea millefolium* growing on roadside in the subalpine zone of Kosciuszko National Park. Photograph by C. Pickering.

Fig. 4. Dr Alec Costin, Dr Pickering, and NPWS Soil Conservation Officer Stuart Johnston examining Yarrow growing on Mt Twynam. Photograph by C. Kelly.

results. They show that the recommended chemical control for Yarrow in the Australian Alps is having little effect on containing the vegetative spread of the weed (Sanecki 1999).

To better quantify the threat of Yarrow in Kosciuszko National Park a four-year study into the population dynamics and invasive biology of the species is being conducted. In addition, the New South Wales National Parks and Wildlife Service is conducting chemical efficacy trials. Preliminary findings of both projects indicate that the emphasis for control of Yarrow must be placed on long-term management that involves the prevention of rhizome growth, suppression of seedlings, and seed and rhizome eradication. In rehabilitation work like this, alternative measures such as biological control and the use of competitive native species need to be investigated in addition to the selective use of herbicides (Crawley 1997). Effective management during the construction of infrastructure is also vital. This includes reducing site disturbance and using uncontaminated earth-construction materials. The trick is to find Yarrow's Achilles heel.

Acknowledgements

The authors are grateful to Graeme Enders and Stuart Johnston who commented on an earlier draft of this paper.

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Celebrating Our Parks – Proceedings of the First Australian Symposium on Parks History (Mount Buffalo, 16-19 April 1998)

Elery Hamilton-Smith (ed.)

Available from: *Rethink Consulting, P.O. Box 36, Carlton South, Victoria 3053. ISBN 0 646 36675 0 $35.00 (plus $8.50 handling and postage)*

The history of conservation and the national park concept are under-researched fields in Australia, even though we have a long and deeply felt tradition about these matters, and plenty of reason to be interested in them for practical reasons. This seems surprising, as parks are generally a positive and enjoyable aspect of things environmental and it would seem more likely, therefore, that people would be keen to study them and in so doing, to celebrate them. Given the depressing nature of a good deal of news and ideas about 'the environment', the stories of substantial vision, achievement and continuing community commitment to our Parks system could do with more attention than they get.

The Symposium 'Celebrating Our Parks' and its Proceedings which are the subject of this review, was a successful and noteworthy attempt to address this deficiency. The Symposium was one of the events which celebrated the centenary of National Parks in Victoria, and Mount Buffalo National Park in particular. Elery Hamilton-Smith not only organised the Symposium, but also edited and published its Proceedings. The papers included in the Proceedings cover a good representation of the history makers of recent generations. These are from the former Premier, Sir Rupert (Dick) Hamer, and two former Directors of National Parks in Victoria (Don Saunders and John Brookes). Other well known figures in policy and recording of policy in recent times are also included, such as National Parks Advisory Council members Geoff Durham and Rachel Faggetter, and the first Parks Planner (and cultural historian) Jane Lennon. There are also contributions by rangers, historians, current administrators, and community members. In addition, papers are presented from a strong contingent of overseas and interstate speakers, including Susan Markham from Acadia University, Nova Scotia. Her papers, and those from New Zealand, Queensland, Tasmania and New South Wales, bring out many of the parallels between Park systems in Canada and Victoria and the other States. Therefore this collection of papers on park history offers a varied, broad, personal and authoritative overview of a huge range of ideas, issues and experiences.

The papers are fairly loosely organised under the headings: Building the Victorian National Park System, Parks in a Cultural Context, Victoria's Alpine Parks, A Diversity of Parks, Wider Perspectives on Parks, and People and National Parks. Across these broad groupings, several themes emerge repeatedly.

Some of these are:

- The significant role played by many individual citizens. At first this role was in contesting the general exploitation of public land, as well as in establishing, defining and maintaining a statewide system of reserved land. Then later, it was in pioneering the parks system. These citizens include scientists, public servants and community activists such as von Mueller, Stirling, Baldwin Spencer, George Perrin, Crosbie Morrison and Ros Garnet, who not only had the vision and took the lead but also inspired countless other Victorians to support them and to love and serve their parks.
- The range of bodies associated with parks and park management. These

include those who fought for them, the Field Naturalists Club of Victoria, the Town and Country Planning Association and the VNPA. There are those that determined their existence - the visionary Bill Borthwick and the LCC; those that managed or administered them - Committees of Management which ran many parks up until 1975; and various versions of a National Park Service with its many committed public servants. There are those who developed them - the Victorian Railways and the RACV. And of course those that opposed them the Forest Commission, many Shire Councils, resource user groups.

- The way in which the same battles between the same kinds of protagonists are fought time after time. This is 'the tug-of-war between those who would exploit public land in all its forms and those who would preserve it' as described by Dick Hamer. This struggle continues in each generation. The outer appearance of the argument fluctuates, taking on the form of the current buzz idea to validate economic exploitation, but the inner values remain the same, as do the ingredients that lead to successful defence of the Parks system.
- The significance of, and interest in, the cultural heritage of our parks. This quality is not well recognised in their management, nor is the fact that it enriches rather than diminishes the value of the parks for most visitors. Despite our admiration for qualities such as 'pristine' and 'wild', it is the 'people places' and the 'people experiences' that draw us and intrigue us on most visits, or the recorded stories, rather than the remote and unpeopled landscapes. Yet even today, cultural heritage does not attract its share of attention as an important aspect of our Parks, compared with the dominance of ecological ideas such as protection of significant vegetation species or communities.

This Proceedings contains many stories and points of view that are not easily available elsewhere, as they are 'from the horse's mouth' - current and personal, offered by people who were doing important tasks for the first time. I have used several of them in teaching Parks and Wildlife Management to undergraduates, especially Hamilton-Smith's 'Changing assumptions underlying national park systems' and Don Saunders' 'Towards a representative system of conservation reserves for Victoria'. I would therefore recommend the Proceedings strongly for teachers of natural resource management and libraries where these matters are taught.

Despite the length of history in our parks system, so much that needs to be recorded, shared and reflected upon is very recent and still resides mainly in people's heads and filing cabinets. And our Parks are under constant pressure, both positive and negative, to take on new directions and purposes, before we have adequately recorded or reflected on the old ones. The value of this Proceedings lies in the wealth of personal knowledge and philosophy it contains, and in the sense of pride it communicates in the achievements so far. This Proceedings is an invaluable aid to the important task not only of recording history as a basis for establishing traditions, but also for interpreting or critiquing them.

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For assistance with the preparation of this issue, thanks to Maria Belvedere and Karen Dobson (label printing), Dorothy Mahler (administrative assistance) and Michael McBain (web page).

Kosciuszko Alpine Flora
Second Edition

by A.B. Costin, M. Gray, C.J. Totterdell and D.J. Wimbush

Publisher: *CSIRO Publishing, 2000. Hardback, 404 pp., colour illustrations, maps, photographs. ISBN 0643065229. RRP $59.95*

The first edition of this work, published in 1979, received national and international acclaim, and this second edition will no doubt be similarly well received. Although the title emphasises the contents related to the flora of the area, the book is far more comprehensive. Human association, from annual Aboriginal excursions, to early exploration by Strzelecki and others, the beginning of the pastoral runs, the work of Mueller, the development of tourism, and the impact of the Snowy Mountains Hydro-electric Scheme, is briefly but comprehensively covered in the second chapter. The first chapter clearly defines, by word and illustration, the terms of reference concerning the alpine and sub-alpine environments.

In the third chapter there is an extensive treatment of geological evolution of the Kosciuszko Alpine Area which is essential to a proper understanding of the distribution of the various plant communities. Our Gondwanan connections are analysed and the sculpting of the present landscape is dealt with in some detail. For the geologically challenged, this is clearly explained with the assistance of an excellent glossary, line drawings and a series of colour photographs delineating the diversified landscapes. In these years of concern with global warming and its possible effects on climate, there is some timely data about the extensive modifications that can occur with a variation in temperature of as little as 3°C.

Having mastered the basic geology, it will become clear in the fourth chapter why the various plant communities occur where they do. The authors define eight distinct communities, give several examples of the characteristic species to be found in each and where such communities are likely to be found. Once again, the detail is assisted by clear definitions, more than two dozen colour photographs, clear diagrams and a colour coded map in the form of an endpaper. A similar map was given in the first edition, in two sections, as part of the text. It must be said that the endpaper in this edition is easier to understand than the maps in the former, but that it lacks any reference to the contour intervals or altitude of reference points.

This chapter is essential in understanding why species occur where they do. It also helps the understanding of why there are apparent disjoint distributions, why habitats may contain variations in the general scheme, and the manner in which the vegetation of a given area can alter even without the interference of the human element.

These essential introductory chapters occupy less than one fifth of the book, and the next seven pages comprise a list, in taxonomic order, of the 212 native species, subspecies and varieties occurring in the Kosciuszko Alpine Area. In addition, a key is added referring the habitats to the eight plant communities defined previously. The 21 endemic species are clearly indicated. Over 260 colour plates follow. Some of these plates contain separate images salient to the identification of the plant, and all have captions referring to distinguishing features and size. The photographs are not to any particular scale, and some have been magnified as an aid to identification, as they would be with a hand lens. Reference to the notes on identification and description will clarify any problems with size.

A twelve page bibliography, referable back to the text, will allow the keen student to follow up on any or all of the aspects covered in the book. The following

142 pages of taxonomic information brings this edition up to date with current knowledge published in the Floras of Victoria and New South Wales, as well as in the volumes of the *Flora of Australia* published so far. No apologies are offered for the reasonably technical nature of this section, the use of which is enhanced by a twelve page glossary of botanical terms. Throughout the descriptions there are cross references to the relevant illustrations. Finally there is a very full index, each species named having a reference to the pages on which the description occurs, its appearance in the general text and the relevant colour plate.

In addition to this hardback volume, there is a paperback **Kosciuszko Alpine Flora Field Edition** of 245 pages by the same publisher and authors. This contains the same material as the hardback with the exception of the taxonomic identification and description. This shorter edition is priced at $29.95.

This beautifully produced book is now available, and as the reviewer said of the first edition, 'see it and you'll want to possess it'!

R.J. Fletcher
28 Marjorie Avenue,
Belmont, Victoria 3216.

We regret to announce the death of Dr George Thomas. George, an Honorary Member, had a long association with the club, and had been a member since 1942. An obituary will appear in a later issue.

We were also saddened to hear of the death of Stefanie Rennick on 3 January, 2001. Stefanie was tireless in her commitment to conservation of the flora of the Mornington Peninsula. A tribute to Stefanie will appear at a later date.

A Second Assistant Editor

We are pleased to welcome Anne Morton as Assistant Editor for *The Victorian Naturalist*. Anne has worked as a desktop publisher on the journal since 1997. We are looking forward to working with Anne on your journal, where her expertise in administration, proof-reading and desktop publishing will be welcome.

Anne is a biologist and her field of interest is the ecology of foxes in an urban environment.

Merilyn Grey and Alistair Evans

John Paul Stewart

2 February 1934 – 21 December 2000

John Paul Stewart was born in Footscray on 2 February 1934. John was a good child and his father once said he could not recall having smacked him, nor was there any need for serious remonstration. John attended St. John's School in West Footscray. He then won a scholarship to attend St. Joseph's Technical College in South Melbourne. He became dux in his last year there.

During his late teens, John took an interest in photography. He enjoyed taking photographs of friends' weddings and babies and he developed the pictures himself. In later years John spent more time and film photographing grass seeds, flowers and unusual fungi found in the western suburbs.

John started work as an apprentice plumber at Maize Products, Footscray. He did his stint of National Service training in the 50s. He said he finished his training the fittest he had ever been in his life. John loved ballroom dancing and went to such events at every opportunity. He also enjoyed underwater fishing, but it lost its appeal the day he almost drowned.

John worked at the Fawkner Crematorium and Memorial Park from 1968 until his retirement in February 1999. In the last 30 years he had many interests. Time was spent with his children driving them to calisthenics, tennis, cricket, school functions, speech and drama classes. He said it never failed to be a miserable night, weatherwise, for parent-teacher interviews. When the local scout group needed a leader at different times, John took on the role over a period of 15 years and as a result attended scout jamborees all over Australia.

He had many interests – weaving, gemstones, Adult Education Association Geology and finally as a field naturalist. I first got to know John through AEA Geology. It was the practice after taking an Adult Education Geology course to join the AEA Geology Group and continue one's interest with lectures and excursions in the Association. At the time John was President of that group and he convinced me to lead excursions to central Victorian geology sites.

When John was involved with AEA Geology and the Melbourne University Geology Department, he went on field trips all over outback Australia as their cook. (He had never peeled a vegetable at home!) He kept journals of his many trips and in later life used a computer to keep track of his plant lists.

When the AEA Geology Group disbanded, the remaining members then joined the FNCV Geology Group, which had the same aims as the AEA Geology Group. John joined the FNCV in 1990 and once a member, he linked his geology with botany, concentrating on the western suburbs, and he became most involved with native grasses and plants and the impact of urban living on remnant grasslands.

At least once a week, or perhaps fortnightly, he would visit the Herbarium to have a plant or seed identified. Sometimes he did not agree with their conclusions and invariably he was correct. He wrote articles on remnant vegetation in *The Victorian Naturalist* and took members of our Club on several excursions in western and northern suburban localities. One article carefully documented a list of plants in the remnant vegetation of the Fawkner Memorial Park (excluding the deliberately planted gardens) where he worked (Vol 109 (3), 1992, pp. 74-79).

A funeral service was held for John at R.C. Corpus Christi Church Glenroy on 27 December 2000. Dorothy Mahler and I attended with Ian Stewart, an FNCV member and cousin of John.

John Stewart's cheery countenance, integrity and faithfulness will be sorely missed by his family and Club members.

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Pythons of Australia: a Natural History

by Geordie Torr, illustrated by Eleanor Torr

Publisher: *University of New South Wales Press, 2000. 103 pp. 16 pages with colour plates. RRP $32.95 (incl. GST), paper cover*

Anyone who has wandered into one of the growing number of pet shops selling native wildlife will have realised that pythons are becoming increasingly popular as pets. This popularity is leading to a greater awareness of these intriguing snakes, particularly amongst those of us unfortunate southerners who do not share our local environment with pythons. It is no longer only biologists and keen amateur herpetologists who have an interest in information about the biology and ecology of pythons; now a far wider group of pet-owners want information on these fascinating animals. 'Pythons of Australia' is a text that will appeal to all of these people, as well as students and anyone with an interest in the environment or Australian wildlife.

Geordie Torr is a writer for Australian Geographic magazine, and the skills he employs to popularise science and the environment for this magazine are evident in 'Pythons', with somewhat complex concepts explained in a manner that will be easily understood by all readers. Perhaps more importantly, Torr is a protégé of Professor Richard Shine, arguably Australia's (and one of the world's) foremost authority on snakes. The work of Shine and his students, as well as the extensive research on pythons conducted by Gavin Bedford, forms the basis of most of the information in this book. The work of these researchers provides much recently collected data from which to construct a comprehensive overview of the history, biology and ecology of pythons.

'Pythons of Australia' is one of a series of natural history books that examine Australian native wildlife. The bulk of the other books in the series has tended to target more iconic species (e.g. Kangaroos and Koalas), or those that fit the 'cute and cuddly' profile (e.g. Mountain Pygmy-possum and Little Penguin), although Harold Heatwole's 'Sea Snakes' is an obvious exception. Unlike other books in the series, 'Pythons' provides an overview of the captive care and breeding of pythons, a feature that will undoubtedly give this book broader appeal than others in the series.

The book commences with an examination of the history of Australian pythons, from the fossil record to the discovery of modern pythons, acknowledging that, prior to European incursion, pythons were well known to the aborigines and are a notable feature of aboriginal art. The taxonomy and biogeography of pythons are explored, as well as the striking convergent evolution between the spectacular Green Tree Python of Australia and New Guinea, and the American Tree Boa of South America. The section on biogeography incorrectly states that, within Victoria, pythons are restricted to the more arid regions in the north-west. Two subspecies of *Morelia spilota* occur within Victoria. The Carpet Python occurs along the Murray River from near Walwa in the east, to the border with South Australia in the west, as well as various localities considerably south of the river in the north of the State. The Diamond Python occurs in far east Gippsland. This is a minor criticism, however, as the book must take a broad-brush approach to the subject of species' distribution.

The anatomy and physiology of pythons is then discussed, covering both external and internal anatomy, as well as senses, metabolism, digestion and water relations/excretion. The text is interspersed with some trivial gems, including the fact that the Black-headed Python is able to regenerate its tongue if it is damaged! Many of the complex physiological and experimental concepts in the text are handled admirably by the author, bringing them easily into the realm of the lay reader.

Based largely on data collected during radio-telemetry studies, Chapter 3 covers the behaviour of pythons, but includes information on locomotion, spatial subdivision and shelter sites. Although infrequently observed, pythons display numerous interesting behavioural traits, ranging from ritualised combat amongst male snakes in the breeding season, to secreting themselves in the ceilings of houses in winter, unknown to most of their human co-tenants! Unfortunately, several of the graphs in this (and other) chapters do not have 'stand alone' explanations of all graphical symbols or axis titles, although the significance of the graphs can be gleaned from the accompanying text.

Chapter 4 covers reproduction and life history, exploring such themes as reproductive behaviour, gestation, incubation, clutch sizes and frequency and hatching, as well as post-hatching traits such as growth, sex ratios and sexual dimorphism. A particularly interesting aspect of python reproductive behaviour is explored in this chapter. Unusually for an ectothermic animal, female pythons are able to generate heat internally to assist in the brooding of eggs. Using a process known as 'shivering thermogenesis' the female uses regular spasmodic muscle contractions to raise her body temperature well above the ambient temperature. She does this whilst coiled around her eggs, transferring her warmth to the eggs and helping to maintain them at a high and stable temperature. In the section on longevity and mortality a range of species that prey on pythons is mentioned, however foxes are not specifically included amongst these. Predation by foxes appears to be one of the major threats to the Carpet Python in Victoria, and is one of the reasons this subspecies is considered threatened in this State.

Food and feeding is covered in Chapter 5, including the types of prey taken by various python species and the methods used to capture these prey. As Torr points out, the ability of pythons to consume relatively enormous prey is 'the stuff of legend' (p. 15), and taking prey up to the size of pigs and wallabies is not uncommon for some larger python species. Most adult pythons prey largely upon birds and mammals (although the Black-headed Python takes few mammals, relying instead on a predominantly reptilian diet), although juveniles of most species tend to eat mainly lizards.

The conservation and management of pythons is discussed in Chapter 6, where Torr points to the dearth of data on the abundance, distribution, ecology and processes threatening many python species. Some species of python are considered locally threatened in certain areas, some subspecies are considered threatened by various state government agencies (such as the Carpet Python in Victoria), and the Rough-scaled Python is known from only three specimens. Like so many other species of native wildlife, the greatest threats to pythons come from habitat destruction and introduced predators, and only the amelioration of these threats will create long-term security for the snakes.

Chapter 7 covers the captive care of pythons, and should make this book particularly attractive to herpetoculturalists and those considering acquiring a python for a pet. The added advantage of appealing to this market is that people keeping pythons will be able to discover so much more about their serpent companions than is offered in most books on the captive care of reptiles. The final section, 'Species accounts' provides a profile of each species, and will allow people with captive pythons to enjoy the wider, natural context of their pets.

'Pythons of Australia' is an attractive book, and a useful addition to the library of biologists, students and both experienced and novice amateur herpetologists and will hopefully stimulate further interest and research into these animals. It contains 34 glossy colour plates, many showing interesting and engaging natural history traits such as feeding and egg laying. Of particular interest is Gavin Bedford's photographs of an albino Olive Python. Typographical errors, whilst present, are few and do little to detract from an interesting, informative and quality text, and I heartily recommend it.

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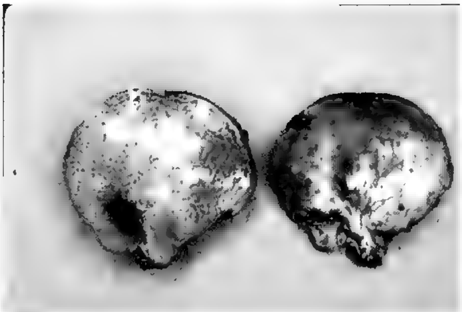
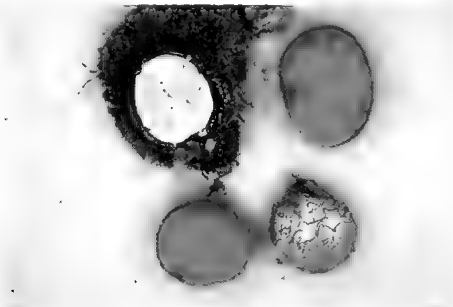
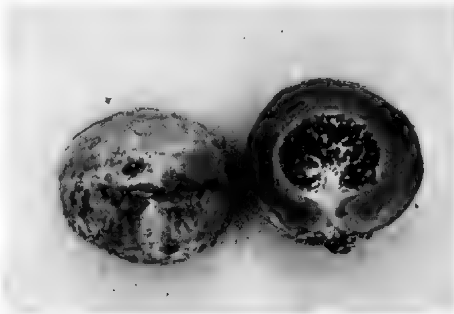


A. General appearance of fruit body of *Zelleromyces* sp.

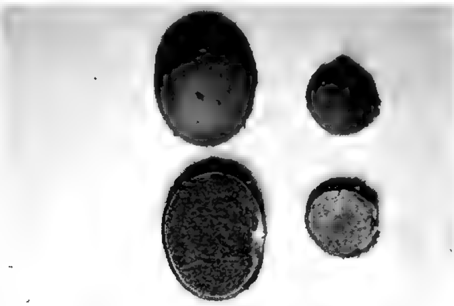
B. General appearance of fruit body of *Macowanites* sp.



C. *Nothocastoreum cretaceum*, showing powdery interior.

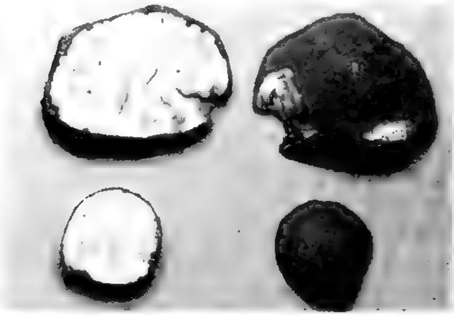


D. *Gelopellis* sp., showing gelatinous interior.

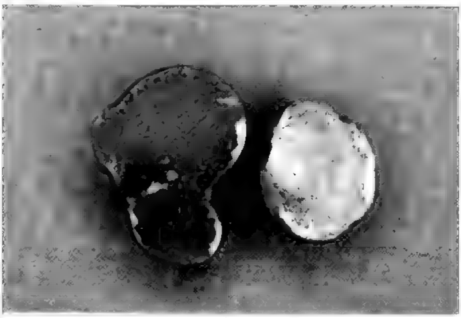


E. *Protoglossum luteum*, showing sponge-like interior.

F. *Mesophellia oleifera*, with central sterile core.



G. *Labyrinthomyces varius*, with solid interior.

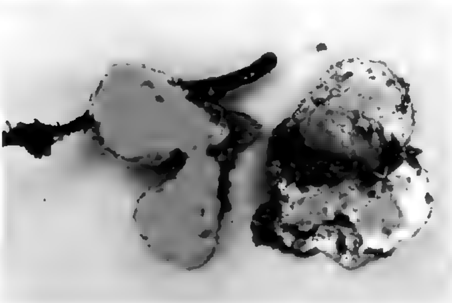


H. *Zelleromyces* sp., note latex produced on cutting fruit body.

PLATE 1 – all photos by Teresa Lebel

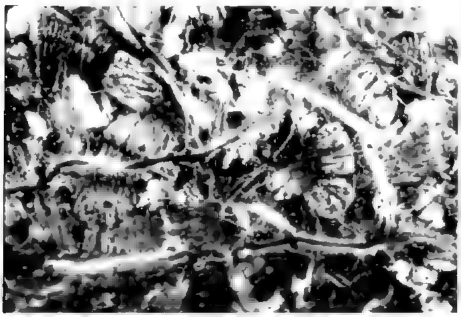
A. *Aleuria aurantiaca*, an ascomycete

B. *Dermocybe* sp., a basidiomycete.



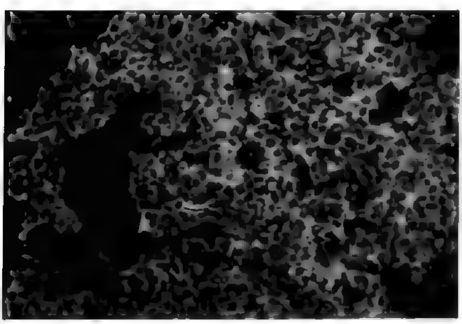
C. *Glomus* sp., a zygomycete (pea-truffle).

D. *Hebeloma aminophilum* or the 'Ghoul fungus', growing amongst the carcass and bones of a dead animal



E. Mycorrhizal root tips of *Alnus* sp. (Alder) in pot culture.

F. Truffle fruit body pushing through soil, causing soil to be raised.



G. Sample from a ground up faecal pellet of Northern Flying Squirrel showing the large number of different fungal spores present.

H. Truffle fruit body in situ after raking the leaf litter aside.

PLATE 2 – all photos by Teresa Lebel

A. *Cymatoderma elegans*, Bangalee. Photo: Pat Jordan.

B. *Plectania campylospora*, N.S.W. Photo: Pat Jordan.

C. *Vibrissea dura*, Tasmania. Photo: Bruce Fuhrer.

PLATE 3

The

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Cover: *Entoloma virescens*, one of the few blue fungi, Lake Matheson, New Zealand. Photo: Ilma Dunn.

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Native Truffles of Australia

Teresa Lebel[1]

Abstract

Information is presented on the biology, ecology, general taxonomy and diversity of truffles in Australia. A definition of what truffles are is provided, and the importance of their interactions with plants and animals in native forests is summarized. Several hundred species have been described from Australia, yet this is probably a small proportion of the total number of species present. A general guide to where to look for and how to collect truffles is also provided. (*The Victorian Naturalist*, **118** (2), 2001, 38-43.)

Introduction

Truffles (both true and false) do occur in Australia. Several hundred species of truffles have been described, mostly from the higher rainfall, tall forests of coastal regions. The diversity of truffles found in the last century in Australia is comparable to that of Europe, where the level of taxonomic and gastronomic interest has been much higher for several hundred years.

Truffles are fungi which either do not actively discharge their spores and/or have fertile tissue (spore-bearing) which matures in an enclosed, below-ground (hypogeous) or partially exposed (emergent) fruit body. These fungi, which are relatives of the cup fungi and gilled mushrooms, have evolved a spore dispersal strategy that depends on animals and many have strong odours which act as attractants (Castellano *et al.* 1989; Claridge and May 1994; Maser *et al.* 1978; Trappe 1979). Some Australian mammals, such as the Long-footed Potoroo, rely on these fungi as a food resource for a large portion of their diet all year round (Claridge *et al.* 1996). The majority of truffles are thought to form beneficial (mycorrhizal) associations with the roots of many trees and shrubs, acting as buffers against stresses such as diseases and aiding in nutrient cycling and the exchange of nutrients between plants and fungi. The interactions between truffles, plants and animals have implications for management and conservation of all these groups. This article presents information about the biology, ecology, general taxonomy and diversity of truffles in Australia. It also provides a guide to where to look for and how to collect truffles.

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What are truffles?

Like mushrooms, truffles are ephemeral fruit bodies that produce spores by which new colonies of the fungus are established. Unlike mushrooms which fruit aboveground, truffles typically have fruit bodies that mature below ground. The spore-bearing tissue is usually completely enclosed by an outer covering (called a peridium) or may be exposed to some degree, but the spores are retained (i.e. no spore print is obtainable as it is in mushrooms) until the fruit body decomposes or is eaten. Truffles are quite variable in size, shape, colour, texture, odour, overall appearance and microscopic features. In size, truffles range from a five cent piece to larger than a tennis ball, and can weigh over 400 grams. The fruit bodies mostly look like small pebbles or potatoes (Plate 1A) but can also have the appearance of an aborted mushroom (Plate 1B). A full range of colour from pure white, flesh tones, drab browns and yellows to brilliant orange, green, red, purple or blue is visible on the exterior and interior of fruit bodies of different species. When cut in half truffles may be powdery (Plate 1C), gelatinous (Plate 1D), sponge-like (Plate 1E), or have a central core of sterile tissue (Plate 1F), or solid with a marbled appearance (Plate 1G). A few truffles produce a milky latex when cut or injured (Plate 1H) and some change colour. Most Australian native truffles have a chambered appearance in cross-section.

The truffle fruit body form has arisen several times in three quite different lineages of fungi: the ascomycetes (cup fungi and allies - Plate 2A), basidiomycetes (mushrooms, puffballs, and bracket fungi - Plate 2B), and zygomycetes (Pea-truffles - Plate 2C). This diversity of origin is apparent in the variety of colours, textures, odours and overall structure of the fruit bodies of truffles. Many truffles can be clearly recognised as related to specific genera of fungi which have above-ground fruit bodies. These relationships are based on the similarity of microscopic characters such as spore ornamentation, or shape and type of sterile cells. So, *Tuber* (truffle) and *Peziza* (cup fungi) have similar microcharacters as do *Hydnangium* (truffle) and *Laccaria* (mushroom), *Protoglossum* (truffle) and *Cortinarius* (mushroom), and *Rhizopogon* (truffle) and *Suillus* (bolete) (Bruns *et al.* 1989; Trappe 1979). These relationships have been confirmed from studies of DNA sequences; however, many other hypothesised relationships remain to be tested using molecular tools. A few taxa defy placement in known groups and are placed in their own families and/or orders, e.g. Mesophelliaceae, Elaphomycetales.

The three main groups of truffles can be easily distinguished by differences in how the spores are formed at the microscopic level. Ascomycetes produce up to eight spores inside globose to cylindric sac-like cells called asci (Fig. 1). Basidiomycetes produce up to eight spores on the outside of club-shaped cells called basidia (Fig. 2), and zygomycetes produce large spores at the end of hyphae. It is difficult for the casual observer to tell the different groups of truffles apart on sight. However, definite macroscopic differences are detectable by the experienced eye (Trappe and Castellano 1991).

Terminology

Many different terms have been used to describe truffles. All the terms describe a particular fruit body form, with partially or completely enclosed fertile tissue, and may be correctly applied to a subset of all the fungi that have this habit. The term 'truffle' is sometimes restricted to the prized edible fruit bodies of the genus *Tuber*, or to ascomycete truffles (the true truffles), with the basidiomycete and zygomycete truffles then referred to as 'false truffles'. Another term used for this group is 'sequestrate' in reference to the spore-producing tissue remaining enclosed even at maturity (Kendrick 1992). For simplicity, in this paper I use the term truffle to encompass the true and false truffles.

Nutrition, Structure and Habit

Macrofungi are made up of extremely fine branching tubes called hyphae (singular hypha) which make up the diffuse, perennial body or mycelium of the fungus in the soil as well as the fruit body of the mushroom or truffle. The hyphal walls are composed of chitin, which is indigestible to almost all animals (this is why eating a large helping of mushrooms may give some people indigestion). Unlike plants, fungi have no means of making their own food, instead gaining nutrition either from living organisms or from their remains after death. Fungi have a large array of enzymes that can digest some recalcitrant substrates such as chitin (insects and other fungi), keratin (hair, skin, horn, feathers), cellulose (plant material) and lignin (wood) (Plate 2D). This ability to use a range of substrates makes the fungi extremely important in recycling of nutrients in ecosystems.

The majority of truffles form mycorrhizae, a close and mutually beneficial association with plant roots (Harley and

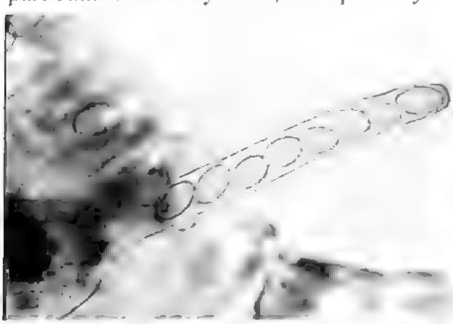

Fig. 1. Location of spores in ascomycetes. Ascus with eight ascospores inside. Photo: Teresa Lebel.

Fig. 2. Location of spores in basidiomycetes. Basidium with single spore attached externally to sterigmata. Photo: Teresa Lebel.

Smith 1983). Indeed, many plants depend on mycorrhizal fungi for seedling establishment and growth, and generally associate with many species of fungi. The fungus forms a tight weft of hyphae around the fine lateral root tips of the plant (like a sock) and penetrates between the outermost cells of the root, without apparently harming the plant cells. In this partnership the plant obtains water and nutrients from the fungus and the fungus gains nutrients and compounds from the plant that it cannot produce itself. The physical barrier presented by the fungal hyphae on the root tips, and the increased nutrient capabilities of the root system in this association, provide a buffer against stresses such as drought and disease (Plate 2E). In Australia most forest trees and many shrubs form mycorrhizal associations, especially from the genera *Leptospermum, Eucalyptus, Allocasuarina, Acacia, Gastrolobium* and *Nothofagus* (Brundrett *et al.* 1996). The majority of Australian truffles appear to be relatively non-selective in terms of the plants that they associate with, for example *Hydnangium carneum* which appears to form mycorrhizal associations with a large number of different *Eucalyptus* and *Leptospermum* species.

Truffles are generally greatest in number and variety near the interface between the litter layer and the hard subsoil layer, i.e. within the top five centimetres of leaf litter and soil. A few, including species of *Tuber, Elaphomyces*, and members of the Mesophelliaceae, fruit more deeply in the soil; some have been found at depths of nearly a metre. Where the soil is compacted, as in heavily-used camp grounds, picnic areas or along abandoned roads, truffles often fruit on the soil surface or close enough that they hump up or sometimes crack the soil (Plate 2F). The mycelium is present in the soil all year; all that is required is the right trigger for fruit bodies to be formed. Truffles may fruit at any time of the year; most species fruit in only one season, but others appear more or less continuously throughout the growing season. In temperate regions, spring and autumn usually produce a flush of truffle fruit bodies, which generally coincides with maximum fruiting of mushrooms. As with many mushrooms, the diversity and extent of fruiting appears to be largely affected by rainfall and temperature. However, the hypogeous nature of the fruit body means that truffles are protected a little more from short droughts or cold snaps and so may be found for longer periods. Ascomycete truffles are slow growing, taking many months to mature and then slowly decay. In contrast, many basidiomycete truffles tend to be ephemeral; the fruit bodies form, expand and mature and decay over a few weeks. Zygomycete truffles may be found all year round.

Diversity and Distribution

Truffles occur worldwide in a diversity of habitats, wherever suitable plant associates grow. Australia has one of the highest levels of diversity of truffles in the world: 83 genera and 294 species are currently known, and several more genera and species are currently being described. Information from recent studies in Australia, both taxonomic revisions of specific genera or groups and ecological surveys of different habitats, suggests that between 12-24% of species are known (Lebel 1998; Claridge *et al.* 2000 a, b). On that basis, between 1250 and 2450 species may occur in Australia. More than 35% of Australian truffle genera and 95% of species are endemic (Bougher and Lebel *in press*), though a lack of collections from other southern hemisphere countries such as Africa and South America may cause some overestimation of endemism.

Although extensive collections have been made in Australia and New Zealand in the last eight years, much of the data should be considered preliminary as many areas have not been sampled, seasonal data is often lacking, and the area sampled at each site in short, opportunistic surveys is generally quite small. Considerable diversity can be found on relatively small, localised sites if surveys are conducted more than once in a year or over several years, e.g. Claridge *et al.* (2000a) collected truffle fungi twice in a 14 ha area and found 209 species of which 153 were undescribed. Knowledge of the diversity and ecology of truffle fungi is limited, primarily because these fungi can only be reliably identified by their fruit bodies, which are generally ephemeral, seasonally abundant, patchily distributed and often hypogeal, that is, time-consuming to find. A single sampling will 'pick up' only a fraction of the species present at a site, and recording a reasonable proportion requires repeated sampling at regular intervals throughout the year and over several years (Claridge *et al.* 2000 a, b; Colgan *et al.* 1999). Sampling of truffle fungi is further complicated by the high proportion of undescribed species and lack of keys and descriptions, making identification difficult.

Mycophagy

As the fruit bodies of truffles typically mature below ground they must be removed from the soil if their spores are to be dispersed. This is generally accomplished by insects and other animals which rely on the truffles as a food resource (Fig. 3). Many of the truffles produce strong odours which act as attractants when they are mature, ensuring the fungus has its spores dispersed. The recently re-discovered Gilberts Potoroo from Western Australia and the Long-Footed Potoroo from eastern Australia rely on fungi year round for up to 90% of their diet (Claridge *et al.* 1996). Examination of faecal pellets shows that the animals are finding a greater diversity of truffle species (based on spore types) than is apparent from fruit body collections made in the same areas (Plate 2G). Other Australian animals such as native mice and rats may eat significant amounts of truffles, especially in autumn (Claridge and May 1994).

The edibility of Australian truffles for human consumption is largely untested. Aboriginal peoples are known to use several types of truffles for food, medicine and other purposes (Kalotas 1996). Anecdotal evidence of a very few cases of upset stomachs exists in the literature, but these are usually cases of mis-identification of puffballs. Only a few of the several hundred species of truffles are considered delicacies, and all of these are native to the Northern Hemisphere. The esteemed edible truffles, species of *Tuber*, have been introduced to Australia on the roots of oaks and chestnuts in various commercial ventures in New Zealand and Tasmania (Hall *et al.* 1998). However, none of the Australian native truffles examined for taxonomic purposes so far has the same combination of smell, taste and texture as the 'gourmet' truffles of France and Italy (Fig. 4).

Collecting truffles

Though abundant in Australia, truffles are often overlooked because of the hypogeous nature of the fruit body, and the appearance of some as aborted mushrooms. A fork or a rake is the most important tool for unearthing truffles. A four-tined garden fork with the handle cut to about one metre long is the most comfortable, as it requires less stooping and covers more area than a smaller type of rake. The most likely location for truffles is around the roots of suitable hosts. If searching after the first heavy rains of autumn or during summer periods, the canopy drip-line or base of the trunk are good places to start your search. At any time of year, signs of animal activity, such as digs or turned-over soil and leaf litter are important clues to truffle production. Small mammals usually unearth truffles one at a time, leaving a small pit; they will dig up only the more mature truffles, leaving the less mature to ripen. Hence, the small pits indicate likely places to rake. Other animals

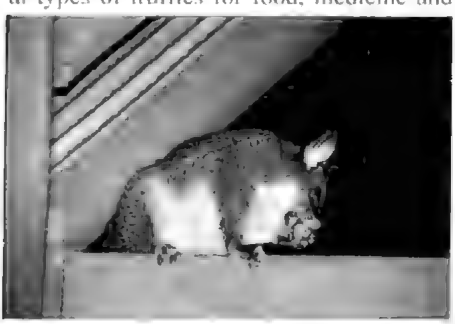

Fig. 3. Possum eating a truffle offered to it. Photo: Teresa Lebel.

Fig. 4. Italian white truffles for sale in a market in the Alba region, Italy. Photo: Teresa Lebel.

such as Lyrebirds turn over large amounts of leaf litter, and it can be quite profitable to follow as the bird actively 'truffles' for you. Random searching can also provide fine collections. Generally a heavy ground cover of grasses or small shrubs is not conducive to high abundance or diversity of truffles.

Choose a spot, then gently rake the litter aside and inspect the exposed humus for specimens. Then rake the humus down to mineral soil while watching for truffles as the soil is turned over (Plate 2H). If there is any suggestion of a mycelial network, continue raking a little deeper or extend the dig. Once a specimen is found, note the depth and kind of material in which it is growing; truffles are often gregarious, and many additional specimens may be nearby in the same substrate or mycelial system. When raking is complete, the soil and litter should be redistributed onto the original spot. More than one species may fruit in a spot, so take notes for each specimen that appears different from the others, and place in separate wax or paper bags or wrap in wax paper. Do not use plastic, as it is a good incubator for bacteria and retains moisture (specimens kept in plastic bags on a warm day rapidly become a slimy mess).

While the specimen is fresh, write notes on its colour and odour, whether a latex is exuded from a cut surface, and whether the specimen changes colour when either cut or bruised (press your finger firmly on the surface, but do not rub; if no immediate colour change occurs, recheck the specimen in 10 minutes). The date, locality (including map reference or latitude-longitude), collector, associated plants and any interesting site information should be noted. A large number of new species and genera of truffles have been found in Australia in the last few years and many more are likely to be encountered. Collections without locality, date and comprehensive notes made at the time of collection may be interesting but are of little value for increasing our knowledge of truffle distributions or diversity. Description of characters made while the truffle is fresh are important in the identification of specimens, and will greatly enhance the value of a collection if it becomes the type of a new species. Each specimen should be sliced in half vertically, through the centre; most specimens will have an apparent point of attachment, so use this to decide where to cut. Many species resemble each other on the surface but differ in the interior. Truffles also resemble seed pods, dried chewing gum, clods of dirt, pebbles, and mushroom buttons. Slicing the specimen in half will allow you to confirm that the collection is at least fungal! For several reasons, well-dried specimens are more useful and easier to maintain than those preserved in liquid. Specimens in good condition can be stored in the fridge for several days if necessary. A food dryer or dehydrator set at 30°C works well to air dry specimens.

Conclusion

We have little knowledge of the potential rarity of truffles. The lack of collections from many habitats and regions in Victoria and other parts of Australia is a problem that needs to be addressed. In the case of truffles this is further exacerbated by the general difficulty in collecting specimens. The high likelihood of finding new species and possibly genera, and the difficulties of collecting, makes the search for truffles an exciting, interesting, and sometimes frustrating endeavour. I hope to address the lack of readily available keys and other identification tools for the truffles of Australia by writing various articles in the *Australasian Mycologist*, *The Victorian Naturalist* and other journals, and also providing a guide to the truffles of eastern Australia in the next few years.

If you are interested in finding out more about collecting and identifying truffles, or helping with ongoing research, please contact the author

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Rules for Hunting Truffles

(a) always seek the landowners' permission

(b) obtain a permit to collect if required (check if you are not sure)

(c) be careful that you do not disturb the root systems of associated plants

(d) replace all disturbed soil and leaf litter

(e) always wash your truffle-fork with water or a weak bleach solution if you are truffling in different areas (this will help reduce the spread of pathogenic fungi)

Notes on Fungimap Target Species

Tom May[1]

Fungimap

Fungimap is a mapping scheme which records distribution and ecological information for 100 distinctive species of Australian fungi (see http://calcite.apana.org.au/fungimap/). Many of the target species are illustrated in Fuhrer (1993) and Bougher and Syme (1998), and in other field guides or sources such as the *Fungi of Australia* series (vols 1A and 1B) and the 'Australian Cryptogams' calendars produced by Judith Curnow and Heino Lepp. Indeed, many of the target species were chosen because they were relatively common, and good illustrations were already available.

Most target species have turned out to have broad distributions, often occurring in eastern and south-western Australia, or else widely through the interior. Some targets, however, were selected because they were thought to be rare or restricted in distribution, with the hope that Fungimap records could confirm this status, and lead to listing of species on state and commonwealth endangered species schedules. Even a lack of records would be useful, since, in comparison to the many hundreds of records of each common species, this would show that the species were indeed rare. Unfortunately, most of the rarer species were not illustrated in the popular mycological literature, so a lack of records could be due to recorders not being familiar with the species. Inclusion of a colour section to this issue of *The Victorian Naturalist* provides the opportunity to illustrate some of the rarer or more unusual target species (some for the first time in colour), as well as a few common species that have been omitted from recent field guides. Species which seem particularly rare are: *Banksiamyces macrocarpus*, *Craterellus cornucopioides*, *Hypocreopsis* sp., *Nyctalis mirabilis* and *Rozites roseolilacina*.

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Target species

There are few blue fungi, and none with the tone and richness of colour of ***Entoloma virescens*** (front cover), whose conical cap (to 50 mm diam.) and stem are uniformly an intense sky blue.

Cymatoderma elegans (Plate 3A) is a large (up to 30 cm diam.), stalked fungus which grows on wood, with the spores produced on the smooth or shallowly-ridged underside of the funnel-shaped cap.

The black cups of ***Plectania campylospora*** (Plate 3B) are up to 50 mm in diameter, and are found on fallen wood.

The stalked pinkish or pinkish brown globular heads of ***Vibrissea dura*** (Plate 3C) occur on fallen wood. Some slime moulds produce stalked globular spore masses, but these are usually smaller on thinner stalks, and are soft and easily crushed. In *V. dura* the head is up to 7 mm diam. and the fruit body is up to 30 mm high.

Nyctalis mirabilis (Plate 4A) is a gilled fungus which produces fruit bodies upon the fruit bodies of members of the Russulaceae (probably species of *Russula*). The cap is up to 30 mm diam. This is Australia's only 'toadstool upon a toadstool'. Known only from a few sites in Cool Temperate Rainforest in Victoria and in Tasmania.

Ping-pong bats is an apt common name for the diminutive ***Dictyopanus pusillus*** (Plate 4B). This is a common species which grows on wood, often occurring in massed colonies. Caps are about 5 mm broad. Although pored, it is closely related to the gilled *Panellus stypticus*.

Among the stalked puffballs, ***Battarraea stevenii*** (Plate 4C) is distinguished by the cap which falls to the ground when the orange-brown spore mass matures. The weathered stalk (up to 35 cm high) resembles a stick from a paperbark.

One of the rarest fungi in Australia is an undescribed species of ***Hypocreopsis*** (Plate 4D) found at a few near-coastal sites on the Mornington Peninsula and west Gippsland. The lobed, brown fruit body clasps branches. The fruit bodies are up to 60 mm across, with individual lobes about 2 mm broad.

Anthurus archeri (Plate 5A) is often confused with the similarly-hued (and malodorous) *Aseroe rubra*, which has bifid arms. The illustrated *Anthurus* is interesting in having one (only) of the arms branched. Arms vary from 30 to 70 mm long.

Compared to the common *Calostoma fuscum*, the rainforest-loving ***Calostoma rodwayi*** (Plate 5B) is smaller and the outer layer does not fall away as a whole cap, but remains as scattered gelatinous scales, and sometimes as a shield peeling away around the scarlet mouth. The peridium in *C. fuscum* is up to 30 mm diam., whereas in *C. rodwayi* it is no more than about 10 mm diam.

The deadly Death Cap ***Amanita phalloides*** (Plate 6A) is an unwelcome immigrant, found under exotic oaks, and invading native *Nothofagus* forests. Distinguished by the yellowish or greenish caps (to 10 cm diam.) and the volva (membranous cup) at the base of the stem.

The several species of the genus *Rozites* occurring in Australia differ from *Cortinarius* in the possession of a membranous ring. ***Rozites roseolilacina*** (Plate 6B) has a dry, pinkish mauve cap (to 11 cm diam.). It is a very rare species in Victoria (known only from the Grampians), and is known otherwise from a few sites in Tasmania.

The stalked cup-fungus ***Aleuria rhenana*** (back cover A) is not a current target species, but is included to allow comparison against the similarly coloured *Cookeina tricholoma*. The latter grows on wood in tropical areas, and has a fringe of long hairs around the margin of the cup. *A rhenana* is up to 25 mm diam. and *C tricholoma* reaches 20 mm diam.

The Crinoline Fungus ***Dictyophora indusiata*** (back cover B) has a yellow cap, initially covered with the slimy spore mass, and a white, lacy frill. The fruit body is up to 20 cm tall.

Banksiamyces are found only on *Banksia*. The relatively large discs (to 25 mm across) of ***Banksiamyces macrocarpus*** (back cover C) are known only from *Banksia spinulosa*.

Preferring Cool Temperate Rainforest, ***Craterellus cornucopioides*** (back cover D) produces clusters of vase-shaped fruit bodies, with spores produced on the dark exterior surface of the 'vase'. Individual fruit bodies are up to 60 mm high.

Fungimap CD-ROM

A CD-ROM compendium of the Fungimap target species will be available in April 2001. The CD-ROM contains numerous photographs (including many of those shown here), along with maps of all species. For many of the target species, multiple illustrations are provided, to show variation and changes during development. All text and photos for the CD-ROM, and the considerable time of Ian Bell in design and programming, have been donated. The CD-ROM will be updated, and expanded to include further targets. Further photos are always welcome.

Acknowledgements

Merilyn Grey and Anne Morton suggested that additional fungi illustrations be included, and are thanked for their encouragement and assistance. Special thanks are due to the photographers who provided the illustrations: Ilma Dunn, Bruce Fuhrer, Sheila Houghton, Virgil Hubregtse, Pat Jordan, Ian McCann, Margery Smith and Anneke Veenstra-Quah.

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Fungimap Inaugural National Conference

22-26 June 2001

Denmark, Western Australia

The Fungimap conference is aimed at Fungimap volunteers, many of whom are relatively new to the study of fungi. There will be field trips to ancient eucalypt forests, coastal heath and woodlands. Workshops will be held on using fungi keys, fungi identification, documentation, preservation and storing fungi for regional and state herbaria and conducting surveys of fungi.

Enquiries to Fungimap Conference, Denmark Environment Centre, PO Box 142, Denmark WA 6333 Phone 08 9848 1644 day, 08 9848 1293 ah. email fungidenmarkwa@wn.com.au

The Impact of Dieback Disease (*Phytophthora cinnamomi*) on Vegetation Near Mt Stapylton in the Northern Grampians National Park, Western Victoria

Julian Di Stefano[1]

Abstract

Phytophthora cinnamomi Rands is a soil borne pathogen that leads to the decline of many plant species across Australia. In this study, presence, cover-abundance and health were recorded for plant species within healthy, transitional and diseased zones in a dry sclerophyll forest near Mt. Stapylton in the north western section of the Grampians National Park, western Victoria. The data were subjected to non-metric multidimensional scaling (NMDS) analysis, and a change in the distribution and abundance of plant species between healthy, transitional and diseased zones was observed. A seed/fungus test using susceptible *Lupinus alba* seedlings was performed, and the results are consistent with the hypothesis that *P. cinnamomi* caused the dieback observed at the study site. The vegetation changes observed represent a transition from healthy *Eucalyptus baxteri* forest with a low heathy understorey to a more open forest with many dead trees and an increased number of sedge and grass species. This transition is expressed as a reduction in biodiversity, density and plant health within diseased and transitional zones, although no effect on vegetative cover was detected. Options for the management of *P. cinnamomi* are also discussed. (*The Victorian Naturalist* **118** (2), 2001, 46-55.)

Introduction

Plant pathogens are an established part of plant communities world-wide. In many regions, they play an important role in the patterns and processes of change that occur within forest ecosystems (Castello *et al.* 1995). However, in some forest ecosystems, plant pathogens may have a destructive impact. This is the case in Australia, where the fungus *Phytophthora cinnamomi* Rands has caused significant ecological damage since its introduction in the early part of the nineteenth century (Bridgewater and Edgar 1994; Barker *et al.* 1996). Over time, infection by *P. cinnamomi* may result in significant changes in the structure and function of forest floral communities (Wills 1993; Wills and Keighery 1994) as well as affecting the distribution and abundance of both vertebrate (Wilson *et al.* 1990; Wilson *et al.* 1994; Newell 1998) and invertebrate (Postle *et al.* 1986; Newell 1997) fauna.

P. cinnamomi is a soil-borne fungus belonging to the class Oomycota. It exists in the form of mycelium or chlamydospores in root and decaying plant tissue (Dell and Malajczuk 1989). Both soil temperature and soil moisture limit the distribution and abundance of *P. cinnamomi*. Optimum soil temperatures for pathogenic activity are between 22°C and 27°C, although infection still occurs in soils warmer than 14°C (Dell and Malajczuk 1989). Barker *et al.* (1996) suggest that in Tasmania, the severity of pathogenic activity is reduced in regions receiving less than 600 mm of rainfall per year. Dispersal occurs when zoospores are transported by laterally moving subsurface water, although surface runoff also has dispersal potential (Kinal *et al.* 1993). Dispersal is also enhanced by human activities. Transportation of infected soil (for road construction, for example), has led to the introduction of *P. cinnamomi* to previously unaffected areas (Wills 1993).

In the Grampians National Park, western Victoria, areas infected by *P. cinnamomi* were first observed in the early 1970s (Kennedy and Weste 1986). More recently, a new section of forest displaying characteristics consistent with *P. cinnamomi* infection has been identified within the park, and this area provided the site for the current study. The major objective of the present study is to identify patterns of vegetation change between healthy and infected regions. A secondary objective is to discuss the suitability of current and proposed management strategies for controlling *P. cinnamomi* in native forest areas.

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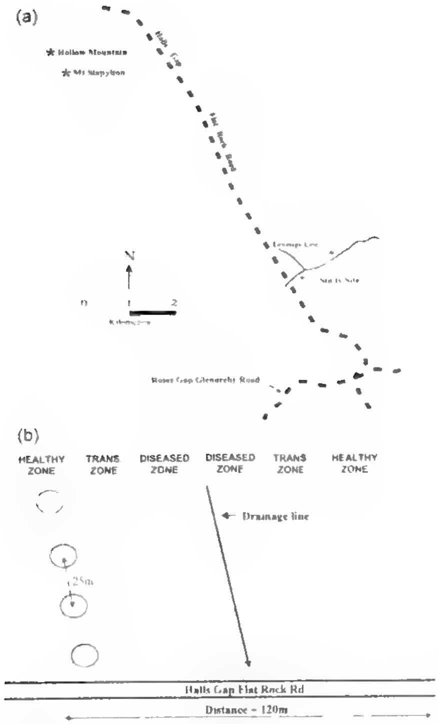

Fig. 1. Study site (a) and experimental design (b). In the experimental design diagram circles represent plots. The area adjacent to the drainage line appeared to be infected by *Phytophthora cinnamomi*.

Methods

Study Area

This study was conducted in the Grampians National Park, western Victoria. The National Park covers 167 000 ha and is noted for the diversity and abundance of flora within it (Kennedy and Weste 1986).

The study site is near Mt. Stapylton in the north-west region of the National Park (Fig. 1a). The region receives around 645 mm of rainfall annually, most of which falls in winter, and is characterised by skeletal, sandy soil with rocky shallow podzols (Sibley 1967). Surrounding healthy vegetation is dominated by *Eucalyptus baxteri*, with a low heathy understorey. Sandstone and mudstone cliffs rise up to the north east of the site. The site has an elevation of 190-200 m and is on a gentle slope (gradient < 5°) with a westerly aspect. The site has a drainage line running through its centre and the strip of forest parallel to the drainage line was believed to be infected by *P. cinnamomi*, as dead and dying *E. baxteri* trees were evident.

Field Work

The sampling program followed a random-sited systematic design. Patterns of vegetation change were investigated by recording the presence, cover-abundance and health of plant species in healthy, transitional and diseased zones. Each zone was divided into two sub-zones, both containing four circular 100 m^2 plots, with 25 metres separating the centre of each plot (Fig. 1b). Vegetation cover was measured using the semi-quantitative Braun-Blanquet cover-abundance scale (Mueller-Dombois and Ellenberg 1974). Species health was measured using a forest health index with a scale between one (healthy) and five (dead).

Laboratory Work

Pre germinated Lupin seedlings (*Lupinus alba*, known to be sensitive to *P. cinnamomi*) were grown in soil samples from the field in order to confirm the presence of a soil pathogen at the study site. Seeds were grown for three weeks in clear plastic, gauze covered containers containing a soil slurry made from 50 g of soil and 100 ml of distilled water. Four seedlings were grown in every container. Twenty four containers were used, one for each plot. After one week and three weeks, seedlings in each container were identified as being either healthy, unhealthy or dead. Healthy, unhealthy and dead seedlings were identified visually.

Data Analysis

Unstandardised semi-quantitative floristic data were used to determine the ecological distance between plots by using the Bray-Curtis dissimilarity coefficient. The resulting matrix was subjected to non-metric multidimensional scaling (NMDS) analysis as described by Kent and Coker (1992) using the DECODA software package (Minchin 1987). Species that were present in only one plot were excluded from the analysis, as they distorted results by making plots unique. Analysis was performed in one to three dimensions, from ten random starts. The two dimensional solution (stress = 0.15) was chosen, as additional dimensions did not provide significantly more ecological information.

Null hypotheses about the number of healthy *L. alba* seedlings three weeks after sowing, mean species richness per plot and mean cover per plot were tested using the general analysis of variance (ANOVA) procedure in GENSTAT. All null hypotheses predicted that variables would not differ between healthy, transitional and diseased zones. Where necessary, post-hoc tests were conducted using the Least Significant Difference method ($\alpha = 0.05$). All data were tested for normality and homogeneity of variance using graphical methods.

Results

Seed/fungus Test

Lupinus alba seedlings were all healthy after one week of growth. After three weeks, the number of healthy seedlings growing in soil from different zones was found to differ significantly $F(2, 69) = 48.94$, $P = < 0.001$. Subsequent post-hoc tests revealed that a significant difference between the number of healthy seedlings existed between all three zones. As expected, the greatest number of healthy seedlings were found growing in soil from the healthy zone and the smallest number of healthy seedlings were found growing in soil from the diseased zone. These results are consistent with the hypothesis that the diseased zone is infected with *P. cinnamomi*, as *L. alba* seedlings are known to be susceptible to this fungus.

NMDS Ordination

The NMDS ordination (Fig. 2) shows that the data from healthy, transitional and diseased zones are separated most significantly along Axis 1. The substantial separation between healthy and diseased plots that can be observed along this axis suggests that there is a discernible difference in the structure of the vegetation between healthy and diseased zones.

Floristic Data

A complete list of the families (n = 25) and species (n = 73) within the whole study site can be found in Table 1. Table 1 also shows the frequency with which each species was found in the healthy, transitional and diseased zones, and the response of each plant species to *P. cinnamomi*. Species have been grouped into three response types on the basis of their frequency in each zone:

(a) Susceptible – species that existed in the healthy zone and were rare or absent in transitional and diseased zones.

(b) Resistant – species that were absent or rare in the healthy zone but relatively common in the transitional and diseased zones.

(c) Fluctuating – species that retained similar levels of cover and abundance within each zone.

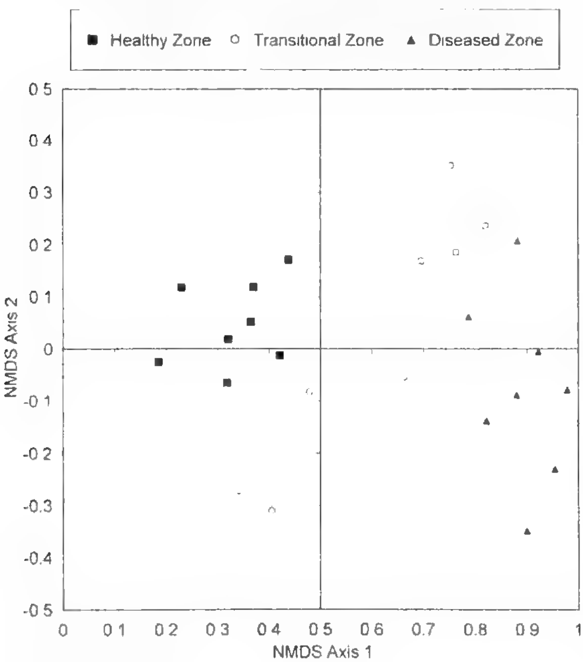

Fig. 2. NMDS ordination of vegetation data.

Family Richness

The number of species within major families is displayed in Fig. 3. Major families were defined as those containing at least two species in at least one of the three zones. These data show that most major families (11 of 13) are represented in all three zones. Moreover, the number of major families represented in each zone changes little, with healthy, transitional and diseased zones containing

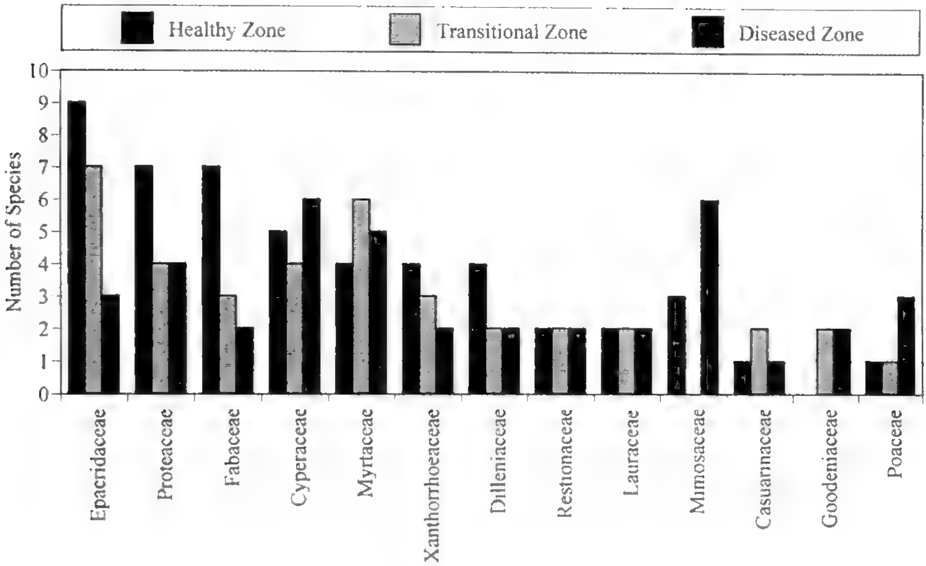

Fig. 3. Plant families that contain two or more species in at least one of the healthy, transitional or diseased zones at the study site.

12, 12 and 13 different families respectively. Nevertheless, the number of species within some families (especially Epacridaceae, Proteaceae and Fabaceae) is much higher in the healthy zone than in the diseased zone.

Species Richness and Cover

Analysis of variance showed that the number of species per plot differed significantly between healthy, transitional and diseased zones: F (2, 21) = 20.65, P < 0.001. Post-hoc tests showed that the number of species per plot in the healthy zone was significantly higher than the number of species per plot in the transitional and diseased zones, but that there was no difference in the number of species per plot between the latter two zones. In addition, the total number of species observed was higher in healthy zones (55 species) than in transitional (46 species) or diseased (50 species) zones. Cover (measured as mean cover per plot) was not found to be significantly different between zones.

Responses of Individual Species to P. cinnamomi

General trends of vegetation change may disguise fluctuations occurring at the species level. Figs 4 and 5 show how the mean cover scores of eight different species changed between healthy, transitional and diseased zones.

In Fig. 4, the mean cover scores for two fluctuating species, *Leptospermum myrsinoides* and *Lepidobulus drapeticoleus*, remain relatively unchanged throughout the three zones. Although the cover score for *L. myrsinoides* fell in the diseased zone, the level of cover was still relatively high (cover = 1.25). The responses of three susceptible species, *E. baxteri*, *Xanthorrhoea australis* and *Isopogon ceratophyllus* are also shown in Fig. 4. It is clear that their cover is much higher in the healthy zone than in the transitional and diseased zones. In contrast, Fig. 5 shows the responses of three resistant species, *Hypolaena fastigiata*, *Hakea rostrata* and *Lepidosperma laterale*. These species show a clear trend of higher cover in the transitional and diseased zones.

Discussion

The NMDS ordination shows that the vegetation structure within the study site is heterogeneous. Based on the presence, cover-abundance and health data used in the analysis, vegetation structure differed between healthy, transitional and diseased zones, with the largest difference being between healthy and diseased zones (Fig. 2).

Table 1. A complete list of families and species found within healthy, transitional and diseased zones. The numbers in this table represent the frequency with which a species was identified in a particular zone (maximum frequency 8). The last column, Species Status, indicates whether the species is susceptible to *P. cinnamomi* (S), resistant (R) or fluctuating (F) based on the frequency data collected in this study. The '?' represents a lack of data and * denotes species that were prolific, but very unhealthy, in the diseased zone.

Families and Species	Common Names	Healthy Zone	Transitional Zone	Diseased Zone	Species Status
Dicotyledons					
Apiaceae					
Hydrocotyle spp.	Pennyworts	0	0	2	R
Asteraceae					
Helichrysum baxteri	White Everlasting	0	0	2	R
Casuarinaceae					
Casuarina muellerana	Slaty She-oak	0	1	0	?
C. paludosa	Scrub She-oak	7	3	1	S
Dilleniaceae					
Hibbertia fasciculata	Bundled Guinea-flower	8	2	2	S
H. sericea	Silky Guinea-flower	1	0	0	?
H. stricta	Erect Guinea-flower	3	1	7	R
H. virgata	Twiggy Guinea-flower	4	0	0	S
Droseraceae					
Drosera whittakeri	Scented Sundew	0	0	1	?
Epacridaceae					
Astroloma conostephioides	Flame Heath	8	3	0	S
A. humifusum	Cranberry Heath	0	0	1	?
A. pinifolium	Pine Heath	8	4	0	S
Brachyloma daphnoides	Daphne Heath	7	1	0	S
Epacris impressa	Common Heath	3	1	0	S
Leucopogon ericoides	Pink Beard-heath	1	0	0	?
L. glacialis	Twisted Beard-heath	7	2	1	S
L. rufus	Ruddy Beard-heath	2	0	0	S
L. virgatus	Common Beard-heath	4	3	3	F
Monotoca scoparia	Prickly Broom-heath	4	1	0	S
Euphorbiaceae					
Phyllanthus hirtellus	Thyme Spurge	3	1	5	F
Fabaceae					
Daviesia brevifolia	Leafless Bitter-pea	5	0	0	S
Dillwynia glaberrima	Smooth Parrot-pea	7	2	2	S
D. sericea	Showy Parrot-pea	5	3	2	S?
Hovea heterophylla	Common Hovea	2	0	0	S
Phylotta pleurandroides	Heathy Phylotta	2	0	0	S
Platylobium obtusangulum	Common Flat-pea	8	2	3	S
Pultenaea spp.	Bush Peas	1	3	1	?
Goodeniaceae					
Dampiera lanceolata	Groved Dampiera	0	0	1	?
Goodenia geniculata	Bent Goodenia	4	2	2	F?
Lauraceae					
Cassytha glabella	Slender Dodder-laurel	6	6	5	F
C. pubescens	Downy Dodder-laurel	8	6	6	F
Mimosaceae					
Acacia longifolia	Sallow Wattle	0	0	1	?
A. mitchellii	Mitchell's Wattle	1	0	1	?
A. myrtifolia	Myrtle Wattle	0	0	2	R
A. pycnantha	Golden Wattle	1	2	3	R?
A. ulicifolia	Heath Wattle	2	2	1	?
Myrtaceae					
Calytrix tetragona	Fringe-myrtle	5	4	6	F
*Eucalyptus baxteri**	Brown Stringybark	8	8	6	S
Leptospermum juniperinum	Prickly Tea-tree	0	2	3	R
L. myrsinoides	Heath Tea-tree	8	8	8	F
L. nitidum	Shiny Tea-tree	0	1	0	?
Thryptomene calycina	Grampians Thryptomene	1	4	3	R

Table 1. Continued.

Families and Species	Common Names	Healthy Zone	Transitional Zone	Diseased Zone	Species Status
Proteaceae					
Banksia marginata	Silver Banksia	1	0	1	?
Grevillea alpina	Mountain Grevillea	1	0	0	?
G. aquifolium	Variable Prickly Grevillea	8	8	8	F
Hakea decurrens	Bushy Needlewood	8	8	7	F
H. rostrata	Beaked Hakea	4	3	8	R
Isopogon ceratophyllus	Horny Cone-bush	6	1	0	S
Persoonia juniperina	Prickly Geebung	2	0	0	S
Rutaceae					
Correa reflexa	Common Correa	8	2	1	S
Sapindaceae					
Dodonaea cuneata	Wedge-leaf Hop-bush	0	0	1	?
Sterculiaceae					
Lasiopetalum macrophyllum	Shrubby Velvet-bush	0	0	3	R
Stylidiaceae					
Stylidium soboliferum	Grampians Trigger-plant	4	4	1	S?
Tremandraceae					
Tetratheca ciliata	Pink Bells	7	1	0	S
Monocotyledons					
Calectasiaceae					
Calectasea cyanea	Blue Tinsel-lily	1	0	0	?
Cyperaceae					
Caustis pentandra	Thick Twist-rush	4	4	3	F
Gahnia radula	Thatch Saw-sedge	3	5	1	?
Lepidosperma filiforme	Common Rapier-sedge	2	0	0	S
L. laterale	Variable Sword-sedge	0	0	3	R
Lepidosperma spp.	Sword-sedges	0	3	2	R?
Schoenus apogon	Common Bog-sedge	2	1	2	F?
Schoenus spp.	Bog-sedges	0	0	1	?
Juncaceae					
Juncus spp.	Rushes	0	1	0	?
Poaceae					
Amphipogon strictus	Grey-beard Grass	0	0	3	R
Poa spp.	Other Grasses	0	0	2	R
Stipa spp.	Spear Grasses	2	2	7	R
Restionaceae					
Hypolaena fastigiata	Tassel Rope-rush	7	8	8	F
Lepidobulus drapeticoleus	Scale-shedder	8	8	8	F
Xanthorrhoeaceae					
Lomandra filiformis	Wattle Mat-rush	2	0	0	S
L. glauca	Pale Mat-rush	3	1	3	F?
Lomandra spp.	Mat-rushes	2	0	0	S
*Xanthorrhoea australis**	Austral Grass-tree	8	8	7	S
Gymnospermae					
Cupressaceae					
Callitris rhomboidea	Oyster Bay Pine	5	5	2	S?

Moreover, the results of the seed/fungus test are consistent with the hypothesis that *P. cinnamomi* was the cause of the observed differences. It is, however, important to note that *P. cinnamomi* was not isolated in this study, and the results of the seed/fungus test may have been due to other fungal species. Nevertheless, the remainder of this discussion will proceed under the assumption that dieback noted at the study site was due to *P. cinnamomi*.

Vegetation Changes

Changes to vegetation structure at the community level involved the transition from *E. baxteri* forest with a low heathy understorey in the healthy zone, to a more open forest with many dead trees and an increased number of sedge and grass species in the diseased zone. This transition represents a substantial alteration in community structure, with a significant reduction in species richness. Other studies

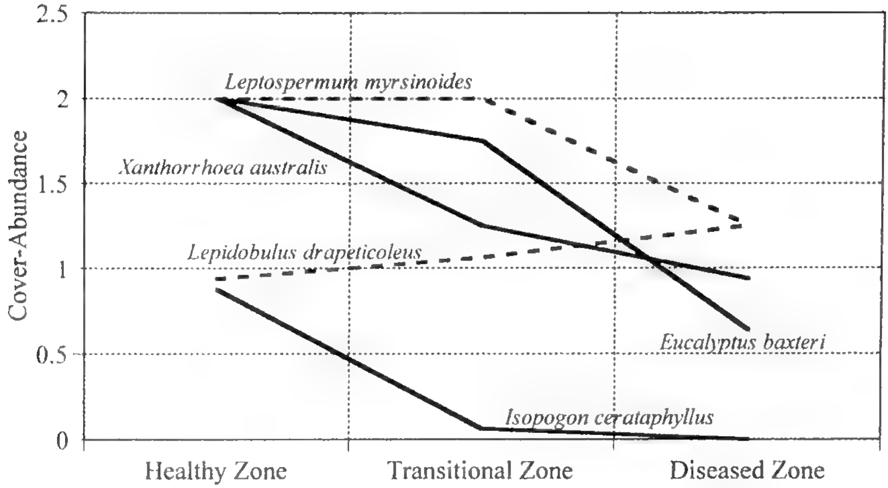

Fig. 4. An example of how the presence of *P. cinnamomi* affects the degree of cover of susceptible species (solid line) and fluctuating species (dashed line) within healthy, transitional and diseased zones. Susceptible and fluctuating species were defined on the basis of their frequency within each zone.

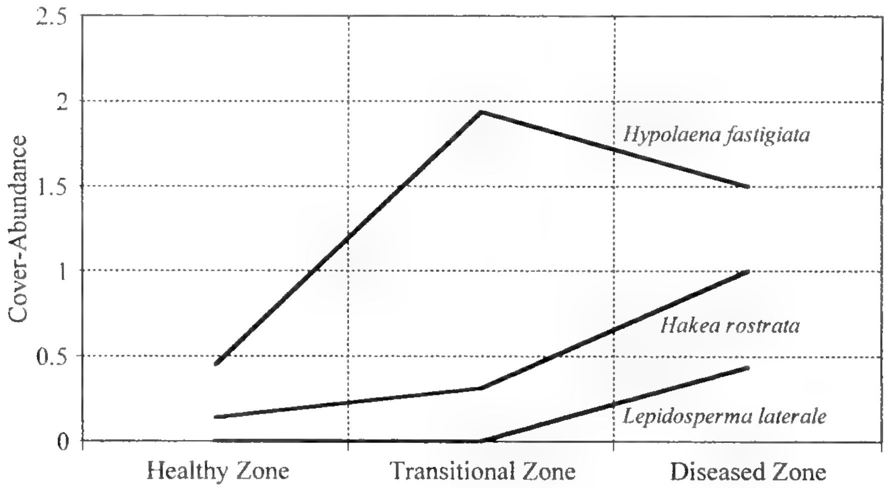

Fig. 5. An example of how the presence of *P. cinnamomi* affects the degree of cover of resistant plant species within healthy, transitional and diseased zones. Susceptible and fluctuating species were defined on the basis of their frequency within each zone.

(e.g. Duncan and Keane 1996) have also found changes to community structure resulting from *P. cinnamomi* infection to be substantial.

The response of vegetation to the presence of *P. cinnamomi* has been similarly described by Kennedy and Weste (1977, 1986) and Weste and Kennedy (1997) at other sites within the Grampians National Park. In the most recent study, these authors observed substantial changes in community structure without significant change in cover or (in contrast to the present study) species richness. Shearer (1994) also notes that *P. cinnamomi* can alter community structure within *Eucalyptus marginata* forest in Western Australia without a concurrent reduction in the number of species. Other studies from Western Australia, however, have suggested that species richness is reduced in areas infected with *P. cinnamomi*. In *Banksia* woodlands on the Swan Coastal Plain, Shearer and Dillon (1996) observed that, on average, diseased zones had seven fewer species than healthy zones. In this respect, the findings of the present study are similar. The results show that healthy areas accommodate more species than transitional or diseased areas.

Susceptible, Resistant and Fluctuating Species

All references to susceptible, resistant and fluctuating species in this study are based on the frequency of their occurrence in each zone (see Table 1). On the basis of this somewhat subjective analysis *Monotoca scoparia*, *E. baxteri*, *X. australis* and *I. ceratophyllus* provide examples of susceptible species. The susceptibility of all of these species has been previously recorded in the Grampians (Kennedy and Weste 1986; Weste and Kennedy 1997) and the latter two in the Brisbane Ranges National Park (Weste 1986). *X. australis* has also been identified as susceptible in Victoria's Kinglake National Park (Duncan and Keane 1996). Kennedy and Weste (1986) have identified nine other susceptible species that were present at the current study site; *Tetratheca ciliata*, *Hovea heterophylla*, *Astroloma conostephoides*, *Hibbertia fasciculata*, *Hibbertia stricta*, *Persoonia juniperina*, *Correa reflexa*, *Leucopogon ericoides* and *Leucopogon virgatus*. All of these species were identified as susceptible in the present study, with the exception of *H. stricta*, which showed a resistant trend.

Hypolaena fastigiata, *L. laterale* and *Leptospermum juniperinum* and *H. rostrata* exemplified resistant species. In the Grampians, Kennedy and Weste (1986) also identified *H. fastigiata* and *L. juniperinum* as resistant, while the abundance of *L. laterale* has been observed to increase within diseased zones at Kinglake National Park (Duncan and Keane 1996). *Gahnia radula*, a species also identified as resistant in this area (Duncan and Keane 1996), as well as in the Brisbane Ranges (Weste 1986), was not shown to be clearly resistant in this study. Although its abundance was higher in the transitional zone than in the healthy zone, its abundance fell to the lowest level in the diseased zone.

Fluctuating species identified in this study included *L. myrsinoides*, *L. drapeticoleus* and *Grevillea aquifolium*. In Victoria, *L. myrsinoides* has been widely identified as a fluctuating species (Kennedy and Weste 1986; Weste 1986; Weste and Kennedy 1997). However, in the Grampians, Kennedy and Weste (1986) observed *L. drapeticoleus* to be marginally invasive. *Casuarina muellerana* has also been identified as fluctuating in the Grampians National Park (Kennedy and Weste 1986). In this study, the density of *C. muellerana* was so low that its response to *P. cinnamomi* could not be identified.

Regeneration of Susceptible Species

The regeneration of seedlings of susceptible overstorey species (especially *E. baxteri*) was observed in transitional and diseased zones. Regeneration of susceptible overstorey species at old diseased sites has also been observed in other parts of the Grampians (Weste and Kennedy 1997). Although susceptible understorey species were not noted to regenerate in this study, the regeneration of many susceptible understorey species has also been observed over the longer term. Nearly a decade after the establishment of their Grampians study, Kennedy and Weste (1986) observed that susceptible species had not regenerated at infected sites. Twenty years after establishment, however, 24 susceptible understorey species from 11 different families were found to be regenerating in old infested plots. These results have been corroborated in other parts of Victoria (Weste 1986; Duncan and Keane 1996; Weste *et al.* 1999) and Western Australia (Wills 1993; Shearer and Dillon 1996).

It is likely that regeneration of susceptible species in old infected areas may be a result of pathogenic decline (Wills 1993; Duncan and Keane 1996). Pathogenic decline may occur for a number of reasons, including changes in the distribution of *P. cinnamomi* and a reduction in the amount of susceptible root tissue at infected sites. Regeneration of susceptible species may also occur if the potential of the pathogen to cause disease is reduced, due, for example, from increased resistance in some susceptible species. Although specific factors causing pathogenic decline may be difficult to isolate, available evidence suggests that the impact of *P. cinnamomi* is reduced over time (Peters and Weste 1997).

Management of *Phytophthora cinnamomi* – a review

The management of *P. cinnamomi* throughout Australia poses significant problems, as there is no comprehensive solution to this disease (Dell and Malajczuk 1989; Bridgewater and Edgar 1994). At present, the major management strategies involve the isolation of diseased areas and the sterilisation of infrastructure moving in and out of diseased sites. These measures, however, are not expected to prevent the spread of the pathogen in the long term (Dell and Malajczuk 1989; Hill *et al.* 1995).

Investigations into alternative management practices are continuing. The use of potassium phosphonate to control *P. cinnamomi* has been investigated in a number of recent publications. Short term greenhouse trials have shown that potassium phosphonate can reduce the severity and incidence of disease in *Pinus radiata* (Ali *et al.* 1999) and a number of susceptible native species (Peters and Weste 1997; Ali and Guest 1998). A field study at Anglesea, Victoria, indicates that foliar phosphonate spray can help to control *P. cinnamomi* in forest and heathland communities, although some species exhibited phytotoxic effects at high concentrations (Aberton *et al.* 1999). In general, chemical treatment of infected regions may be an effective small scale management option if infected sites are identified early (Hill *et al.* 1995).

An alternative to chemical treatment is the use of biological controls. Biological control of *P. cinnamomi* involves the introduction of antagonistic soil micro-organisms into infected regions. Suggested bio-control mechanisms include the use of bioenhanced mulches (Costa *et al.* 1996) and the introduction of cellulase producing organisms into infected regions (El-Tarabili *et al.* 1996). These strategies, however, are primarily directed at controlling *Phytophthora* species in fruit plantations, and are not appropriate for use in the Grampians as the structure and organic content of the soil is not conducive to the survival of populations of micro-organisms (Kennedy and Weste 1986).

In the Grampians, Kennedy and Weste (1986) suggest that fire may be an appropriate management strategy. Severe fire kills *P. cinnamomi* in the top 20cm of soil (Weste 1974), and promotes regeneration in the fire adapted vegetation of the region. In addition, Kennedy and Weste (1977) propose that public education could aid the management of *P. cinnamomi*. Peters and Weste (1997) agree that education should be an important element of an effective management strategy. Informing people about *P. cinnamomi*, and the risk of spreading infection via vehicles and equipment may reduce its rate of spread in the Grampians National Park.

Areas infected with *P. cinnamomi* are not uniformly distributed – they form a non-uniform mosaic of infected patches across the landscape (Weste and Kennedy 1997). Consequently, developing a detailed inventory of diseased regions (Shearer 1994) and the identification of healthy but susceptible micro regions (Kennedy and Weste 1986) may help to manage infected areas. Barker *et al.* (1996) have developed an objective methodology for the selection of sites with a high management priority, and such objective delineation of more and less important areas seems like a logical first step in the development of a management plan.

Better management of *P. cinnamomi* in Australia requires the development of a national management plan. To this end, communication between management bodies in different parts of the country needs to be enhanced (Bridgewater and Edgar 1994). However, the impact of *P. cinnamomi* in a particular region depends on potentially unique interactions between the pathogen and the surrounding ecosystem (Bridgewater and Edgar 1994; Shearer 1994; Castello *et al.* 1995; Shearer and Dillon 1996). The earlier discussion, for example, shows that the same species may respond differently to *P. cinnamomi* at different points in space and time. As a consequence, management strategies, although holistic in nature, must be flexible enough to deal with problems specific to a particular region. This may require the use of different management strategies for different regions, or the integrated use of a number of management techniques to control *P. cinnamomi* in a particular area.

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Field Identification, Ecology and Conservation Status of the Red-chested Button-quail *Turnix pyrrhothorax* in Northern Victoria

Lawrie E. Conole[1] and Ralph Mac Nally[1,2]

The Red-chested Button-quail *Turnix pyrrhothorax* is classified as Vulnerable in Victoria (DNRE 2000). It is generally regarded as widespread, although uncommon (Pizzey and Knight 1997), in New South Wales, Queensland (CYPLUS 1996) and the Northern Territory (PWCNT 1999). In north-west Western Australia, O'Connor (1997a, b) reported three records from an environmental survey at the Argyle Diamond Mine (16°41'12"S 128°25'50"E) and another near Broome (17°57'47"S 122°14'06"E), which added to just six previous Kimberley records. Red-chested Button-quail are also rare in South Australia (Stanger *et al.* 1998; TSN 1998). Marchant and Higgins (1993) describe it as generally uncommon across Australia, but apparently secure. Bennett *et al.* (1998) thought it rare on the Victorian Northern Plains. Its status across Victoria is unclear thought to be present most years in some regions, but only an occasional visitor to other regions depending on seasonal conditions (Emison *et al.* 1987).

The observations reported here come from a more extensive study of the vertebrate fauna of Gunbower Island, Barmah State Forest and the Lower Ovens Regional Park, which focused on the role of coarse woody debris (fallen timber) in influencing biodiversity on the southern floodplains of the Murray-Darling basin (Mac Nally *et al.* 2000).

Habitat use

Although generally considered a grassland species, we recorded Red-chested Button-quail in River Red Gum *Eucalyptus camaldulensis* and Black Box *E. largiflorens* woodland along the Murray River at Lindsay Island (34°08'S 141°07'E) and Gunbower Island (35°45'S 144°18'E) (L.E. Conole, *unpubl. data*). Other observers have found the species in box-ironbark forests at Dunolly in central Victoria (37°00'S 143°44'E) (G. Horrocks, *pers. comm.*) and Chiltern in north-eastern Victoria (36°07'S 146°37'E) (R. Clarke, *pers. comm.*). In New South Wales, Red-chested Button-quail have been found within box-ironbark remnants in farmland in the Capertee Valley (33°07'S 150°10'E) (D. Geering, *in litt.*). The species can be locally abundant in these areas, as appears to be the case on Gunbower Island where it outnumbered Painted Button-quail by about 5:1 at one site (L.E. Conole, *unpubl. data*).

The common factors in these woodlands and forests seem to be areas of bare ground and abundant leaf litter, little or no understorey and patches of tussock grass or sedges. In River Red Gum habitats, there are often drifts of flood debris. This combination of conditions most commonly occurs along drainage lines. The birds normally forage in open areas of deep leaf litter, and retreat to the cover of tussocks or woody debris if threatened. This is contrary to the description in Marchant and Higgins (1993), which suggested that Red-chested Button-quail prefer thick standing ground cover of grasses or weeds.

We believe its occurrence in open woodlands in Victoria may be significantly underestimated, which in turn leads to its overall status in Victoria most probably being in error. The species appears to be a regular visitor to woodlands in northern Victoria, if not a resident. Emison *et al.* (1987) regarded River Red Gum habitats along the Murray River to be the habitat in which Painted Button-quail reach their greatest densities. Even so, it is also the case that Red-chested Button-quail outnumber Painted Button-quail in areas of Gunbower Island and Lindsay Island. We recommend that observers should be wary

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of presuming button-quail in woodlands of northern Victoria to be Painted Button-quail. All 'quail' should be scrutinized carefully before making an identification.

Field identification

Identification of Red-chested Button-quail in the field is probably easier in woodland than in some of the grassland habitats they frequent. We have found Red-chested Button-quail more reluctant to fly than Painted Button-quail. In dense ground cover, birds are probably missed as they run out of the path of the observer rather than flush. In woodland, Red-chested Button-quail typically flush quite late 2-10 m from the observer. On the other hand, Painted Button-quail typically flush earlier - 20-50 m from the observer. Red-chested Button-quail also often allow a longer period of observation in flight than Painted Button-quail. They can generally be relocated after the first flushing, but rarely after a second. When first flushed, Red-chested Button-quail typically fly a short distance, land and then stand motionless to inspect the 'intruder'. After being flushed a second or third time, they usually run out of view very quickly.

The key characters to look for to identify Red-chested Button-quail are:

- clearly smaller in size than Painted Button-quail;
- when viewed from directly behind Red-chested Button-quail look uniformly pale grey across the upperwings and back compared with Painted Button-quail, which are two-toned, warmer brown-grey on the back with greyish upperwings;
- Little Button-quail *T. velox* are clearly pinkish-cinnamon on the upperparts;
- when viewed from side-on, the rufous wash on the underparts of Red-chested Button-quail is obvious, and the thick bill may be seen at close range.

If viewed on the ground, either before flight or when located after landing, the characteristic plumage and bill-size differences can be sought.

Once Red-chested Button-quail had been identified as the most abundant species of *Turnix* at '86 Break' (a forestry track) on Gunbower Island, a number of observers visited the area and found they were able to distinguish between the two species in flight, after a little practice (C. Coleborn and C. Lester, *pers. comm.*).

Foraging

Although Marchant and Higgins (1993) mentioned that Red-chested Button-quail '... glean and scratch in litter ...' and use small circular scrapes for roosting, it is not clear from that description whether they make platelets in the course of foraging in the manner of other species of *Turnix*. Platelet making for foraging has been observed at Gunbower Island (L.E. Conole *pers. obs.*; C. Tzaros, *pers. comm.*) and is typical for the genus. The birds rotate on the spot, scratching out a small circular depression in leaf litter, pecking occasionally at the ground, and can sometimes be detected in dry periods by the small puffs of dust they cause while making the platelets. Foraging occurs throughout the day, although the species has been said to be nocturnal and crepuscular (Marchant and Higgins 1993). In areas where Red-chested Button-quail were found to be abundant, the density of platelets over large areas of ground was marked and relatively uniform (e.g. 10 platelets/m^2, 27 April 1999). At one logging coupe on '86 Break' on Gunbower Island, Red-chested Button-quail concentrated foraging for a short period – around the gouges and depressions made in the ground where sawlogs had been dragged through the woodland.

Status and threats

The Red-chested Button-quail is categorized as Vulnerable in Victoria (DNRE 2000), but is thought to be uncommon and secure throughout the rest of its Australian range (Marchant and Higgins 1993). Few records were made of Red-chested Button-quail in Victoria during the first Atlas of Australian Birds (Blakers *et al.* 1984), and all of these were from grassland or crops. Although it may be irruptive south of the Great Dividing Range and into drier areas of the Wimmera and Mallee of western Victoria, we believe Red-chested Button-quail may be a regular visitor or resident along the Murray River floodplain in northern Victoria. We have found it to be locally more abundant than Painted Button-quail in areas of River Red Gum and Black Box woodland on Gunbower

Island and on Lindsay Island. Although Red-chested Button-quail may be relatively rare in Victoria, it seems to occur more regularly and widely, and utilizes more habitats, than previously thought.

Given that areas of ground cover such as tussock grass or sedges and woody debris seem important to Red-chested Button-quail, we recommend that these habitat elements be managed in riverine forests to ensure appropriate conditions for this species. Grazing by livestock, and removal of woody debris for firewood, are threatening processes for the Red-chested Button-quail in these floodplain woodlands.

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Observations of Skink Mating Behaviour

On a warm, sunny, summer afternoon (10 October 2000) I noticed what at first sight appeared to be a heap of dead garden skinks (*Lampropholis guichenoti*). Closer examination revealed that all were very much alive and that the heap had a definite structure. There were five skinks involved and all were on their backs. The central skink was held to the ground by the jaws of two others attached to each flank. The purpose of this behaviour soon became apparent when one of the attached skinks raised the rear half of its body (with its rather messy intromittent organ at the ready) and curved it over the female. After a union of several seconds the group broke up and the female escaped only to be pinned down again after travelling about 70 cm. As there were a number of excited skinks about I am not sure whether the same group reconvened. I suspect that the matings had been going on for some time and that many males were involved. The sex of the assistants was not obvious to me. The behaviour seemed risky - the cluster of lightly hued bellies was very conspicuous. Furthermore, their natural wariness was lacking. They would have been easy pickings for kookaburras etc. However, the strategy is obviously successful judging by the abundance of these skinks. They are communal nesters and in my limited experience the hatchlings are all ready to emerge at the same time.

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Observations of Black Snake Feeding

Since taking up part-time residency on a Genoa River property in Far East Gippsland I have had many opportunities to view animals I would not otherwise have encountered. Red-bellied Black Snakes (*Pseudechis porphyriacus*) appear to be common and are usually observed curled up in a sunny spot or fleeing. Sometimes a moving snake will 'freeze' when confronted by a walker or vehicle. A 'frozen' black snake can be encouraged to move out of harm's way by very gentle contact – a longish stick is recommended as they can 'thaw' quickly. Very occasionally I have seen a black snake sampling scents with its tongue as it moves over rocks and litter, but until recently I had never seen one feeding.

At midday on 22 December 1999 I saw a loop of active black snake protruding from a shallow pool isolated from the river by lack of rain. The approximately 130 cm long snake was working its head under a rock in about 10 cm of water. Suddenly it emerged with a galaxid about 7-8 cm long. The front two-thirds of the fish was visible. Swallowing was assisted by pushing the galaxid against rocks and against its own flank. All this occurred underwater.

The snake resumed hunting in a systematic pattern by vigorously working its head into every available crevice close to where it caught the fish. It would surface periodically for air – its breaths were audible and then return to the crevices. It varied its approach to any one ledge, sometimes approaching from the left and sometimes from the right. Occasionally there were forward thrusting movements of the body but as the head was out of sight I could not see what was happening. Periodically it would raise its head from the water and check the immediate pool surrounds before resubmerging. Several times it swam to the centre of the pool (depth about 30 cm) where it swept through the sediment before quickly returning to the crevices. Eventually it swam the 3 to 4 metres to the other end of the pool forcing its way into more ledges and through a patch of aquatic vegetation. This resulted in a galaxid leaping from the water onto a rock shelf. While the snake was not looking, I moved from my vantage point and returned the stranded fish to the pool. Without going back to my former position, I continued to watch. I could see that this reptile had disturbed tadpoles, shrimps and a larger decapod. Then the snake abandoned its ledge search and swam into the shallows and raised its head. I found myself 60 to 70 cm from a hyped-up snake with its tongue still flickering. I remembered reading that 'you would be very unlucky to be killed by a black snake'. As I resolved to hold my ground another part of me calculated I was within striking distance and also that any help was hours away. Suddenly my legs stepped backwards and equally suddenly my snake vanished into its pool.

It had been a fascinating half-hour. I was left with the distinct impression that this animal had been working to a plan a strategy involving the stirring-up the centre of the pool so that potential prey fled into ledges or even out of the pool where it would be easier to catch. The snake also seemed to position its body to act as a sort of barrier to stop potential food escaping to deeper water. If this was the strategy, was it learned by trial and error or was it insight or was it an innate behaviour?

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Birds of French Island Wetlands

by Des Quinn and Geoff Lacey

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French Island in Victoria's Western Port Bay is, in many ways, a jewel in the State's flora and fauna heritage, particularly from the avifaunal viewpoint. The island occurs in one of the State's largest Ramsar (internationally recognised wader and waterbird habitat) sites. As with a number of other important sites across the State the island has a 'Friends group' that carries out much important work. Authors Des Quinn and Geoff Lacey, founding members of Friends of French Island, communicate their enthusiasm, interest and commitment to preserving and recording the water and wader birds of the island with this fascinating and well produced book that deserves wide appreciation by all Victorians, not just those interested in birdlife.

The book is divided into five sections: an 'introductory' section on the island and its wetlands, then sections on the coastal wetlands, inland wetlands, wetland birds and their ecosystems and finally wetland management guidelines. Much in evidence is the authors' use of their own data and hand-drawn illustrations, with assistance from many others who are carefully acknowledged.

The book opens with some notes about the authors then gives some brief comments on the island's Aboriginal and European history and other Western Port bird studies. The authors then outline the books' purpose in five points: the publishing of their records and an interpretation of this data; exploration of species and their habitats and hence the importance of the area; guidelines for management of the wetland sites; to show how individuals and groups can achieve conservation goals; and finally to highlight methodology used on the study of the island's wetlands as a means to compare these sites with wetlands elsewhere in Victoria and Australia. Some brief information is given on the island's geology and wetland ecology before the main chapters dealing with the wetland sites.

The chapters on coastal and inland wetlands are clearly laid out so the naturalist or new visitor can gain an insight into each site's water or wader bird community. Common and scientific names are used and the text is supported by hand-drawn maps plus a few illustrations. The importance of each site is stated and notes from the authors' own notebooks are interspersed with the text. This adds a personal dimension that communicates their enthusiasm while giving the reader an immediate impression of a site or observation. Where a site is particularly significant within Victoria or Australia, this is noted and other information sources are clearly referenced.

The last two parts of the book put the bird and wetland data into a State or ecosystem context. Some opinions are given on trends in numbers of species at certain sites, and the state of Western Port's seagrass community is briefly discussed. There are a number of useful tables including a complete (including terrestrial) bird list and records for most wetland sites mentioned in the text. Management guidelines for the wetlands are also discussed based on the Department of Natural Resources and Environment Guidelines of 1996 (NRE 1996).

I had a minor criticism about the images used. Most of the bird photographs in the text are from the Ian McCann collection and unfortunately a number are repeated in different parts of the book. Likewise the line drawings of birds. However, it is the authors' own images of the wetland habitats that are the most interesting, as they show what some sites actually appear like on the ground.

The authors have produced a book that not only details the numerous and varied wetland sites on and around the island but also gives an account of the interaction between the birdlife, their habitats and the chemophysical environment. Although it is not especially a book for the casual tourist, any visitor would find in the publication valuable resource material prior to visiting or if they wished to research the island's water and wader bird fauna. It is a delight to see the use of original, long-term data presented in a complete and informative format that will allow further analysis by the interested observer. The authors' 35 years of observations are clearly evident in this fact-filled publication. For those interested in French Island bird fauna this is an important text to add to your library. It is also the first book to attempt to record and publish details of a major vertebrate group for the casual visitor and ornithologist alike. While not a field guide or a handbook for the pack, I thoroughly recommend the book to all interested in Victorian fauna.

Reference

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Common Australian Fungi: a Bushwalker's Guide

by Tony Young

Publisher: *University of New South Wales Press Limited, Sydney, Australia, 2000 Revised Edition. 154 pp, 16 watercolour plates, 16 photographic plates, softback. RRP $22.95*

I suspect this little volume now holds the record for the number of different editions of essentially the same work, this being the fourth, although two are minor revisions of a previous publication – well on the way to becoming a bibliographic nightmare!

The latter pair have photographs to supplement the watercolour illustrations, minor updates in terminology, an additional introduction and a revised introductory paragraph for the work proper. The watercolours in the latter pair have been separated from their original taxonomic sequence and regrouped alphabetically, and are poorer reproductions than in the first pair. The shape and covering have also changed from hard covered 'paperback' size to a longer narrow paperbacked pocket size. The only difference I could detect between this '2000 bushwalkers guide revised edition' and the '1994 naturalist's guide edition' was a change in key entry 54 (p. 28) and the insertion of *Pycnoporus* here and *Pycnoporus coccineus* at p. 39 and in the index. At the index entry, you will also see a reference to plate 23, where you will look for it in vain, until you realise that it has the caption *Trametes cinnabarina*. (This name change is unexplained in the text, and similar unexplained changes also occur within a few genera.) Unfortunately, a number of such 'design flaws' mars this and the earlier editions, (all by the same publisher), the two most glaring of which are the use of 'old' names in both the key and often illustrations, as opposed to 'new' names in the text, and the failure to indicate plate numbers in the text, which means you are forever thumbing backwards and forwards or using the index.

So, into the work! The 'many hundreds of species of microfungi' alluded to in the introduction is one of the greatest understatements I've ever seen. Perhaps hundreds of thousands. Maybe millions. A single decaying leaf would probably supply the 'many hundreds'. We then run briefly and reasonably interestingly through the main fungal groups, which are illustrated with good, though small, but always unscaled line drawings. I have never, however, seen an entire *Cordyceps* ascospore liberated as illustrated in Figure 9r (p. 8) they usually break into about 100 tiny barrel shaped part spores. The remaining sections of Fungi in the Bushland are generally adequate, although the section on Fairy rings (pp. 10-11) would have benefited from the inclusion of reference to the research indicating the fungal structures underlying fairy rings may be the largest living things on earth! Also adequate (for a bushwalkers guide) are the following sections on Fungi and People and Poisonous and Edible Fungi, though again, there is no reference to the now common use of fungi (usually yeasts) in the genetic engineering of various products.

The Study of Fungi is fine for those already 'in the know', but would benefit from simple illustrations on 'how to ...' - how to make a spore print, section, slide and the like, perhaps a sample record sheet for beginners. The Key itself appears, from my relatively limited knowledge, to be satisfactory, except, as indicated above, for the use of discontinued names – eg. Pleurotus. Cordyceps keys out, assuming you know, or can observe the spore mass is not 'slimy and foul or foetid'! The key does not, however, indicate on which page the species descriptions begin – you have to look this up in the index.

The species descriptions are alphabetic within orders organised roughly taxonomically – a fairly common pattern. The ordering of the watercolours is now purely alphabetic, and the photographic plates appear to have been inserted at random. There is no indication of scale with any of the illustrations - you have to work this out from the species description. The descriptions themselves appear adequate, although again the accompanying (often useful) diagrams where present are both unlabelled and unscaled. Newer terminology has been included as subtext following or under the 'old' name, which is the one used to position the species in the text. Important information re edibility is clearly displayed – you can't say you weren't warned!

The sixteen photographic plates are of good to excellent quality. All would aid in the identification of the species depicted. The sixteen watercolour plates, while intrinsically beautiful, are of variable use with respect to identification and all illustrations are small. I do not, for instance, think I would identify *Lactarius deliciosus* from its illustration (Pl. 18), though I might *Cordyceps gunnii* (Pl. 6).

The work concludes with a useful glossary and further reading, although you would need inter library loan to get hold of some of these! Interestingly, although this contains the more recent releases, it is a considerably cut down version of the bibliography presented in the first 'pair'.

Despite the above criticisms, this is a useful guide, and it is a pity it does not carry a reference to the Fungimap scheme (many target species are included). There are an awful lot of fungi out there, and precious little information on any of them. This work, while suffering from a number of design faults, would enable the lay person, with a bit of effort, to enter in a practical way into the fascinating world of fungi. How many you could identify on a bushwalk – well, that's another question!

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Wildflowers of the Brisbane Ranges

by Clive and Merle Trigg

Publisher: *CSIRO Publishing, Collingwood, Victoria, 2000.*
128 pp, colour photographs. RRP $19.95.

Photographic records of the wildflowers of a region, locality, state or national park collected into books are becoming popular, perhaps with the availability of funds for such projects from government departments. This book is no exception and the authors, based on their experience of 10 years of observation, have compiled a collection of over 400 of the 430 species of the Brisbane Ranges National Park.

Brisbane Ranges National Park is situated 80 km west of Melbourne and 30 km north west of Geelong and boasts a wide range of soils, aspects and terrain that support grassy plants, dry open forests, woodlands, moist shaded sites, rocky sites and dry sandy areas. This is reflected in the rich diversity of the flora.

There is a short introdyctory section on the history and the events that shaped the Brisbane Ranges beginning 450 million years ago, with comments on Aboriginal and European settlement, gold, Geelong's need for a water catchment, timber removal and the adoption of the Brisbane Ranges as a National Park.

The main part of the book is of course the photographs of the flowering plants of the Brisbane Ranges. The species are arranged alphabetically under family and then species. The monocots appear to come first, represented by the Liliaceae and Orchidaceae and a few other family groups. A clump of *Xanthorrhoea australis* (family Xanthorrhoeaceae) with spikes in full-flower is immediately followed by *Carpobrotus modestus* (family Aizoaceae) with no explanation for the change back to the start of the alphabet. Plants are in two groups but there is nothing to explain this.

Some of the larger or more important family groups begin with a descriptive paragraph detailing the characteristics of the family in growth form, leaves, flowers and fruits. Details presented with each photograph are scientific name, common name, family, some limited detail on growth form (herb, shrub, erect annual, tufted herb), height of plant, flower arrangement and width (e.g. capitula to 30 mm, buttons to 15 mm, flowers in clusters, flowers in brown plumes). A short phrase describes where these plants may be found (dry areas, damp flats, widespread in forests, poor stony ground) and when they flower.

There are two very useful aids to identification of plant species in this book. One is the 'colour identification guide', which groups colour and the types of flower arrangements likely to be found in that colour. For instance, under 'pink or red' flowers may be arranged as daisies, peas, spikes and umbels (to name just a few) whilst 'green or brown' can be buttons, clusters, cylindrical or tubular. Page numbers refer to the main photographic section. Secondly, letters after the location of plants refer to the Soils of the Brisbane Ranges map in the back end-paper of the book. Each soil region is shaded with a unique colour and numbered from A-L. Knowing where you are when you try to identify species may aid in differentiating between similar species and genera (provided you are not already lost!).

The photographs are excellent, clear and detailed and provide a close-up view of each subject. Some species are represented twice with another photo to give more detail, e.g. the flower of *Caleana major* followed by a photo of its leaves, or *Eucalyptus camaldulensis*, a photo of the tree and one of the leaves and buds. Ideally, there would have been more photos of growth form as well as flower close-up, but perhaps there was not room or the budget would not allow extra photos. Ideally, too, there would have been more detail in the text to draw attention to the characteristics that differentiate similar species from each other, such as flower and leaf form.

There is a map of Brisbane Ranges National Park, which includes local and park roads, walking tracks, barbecue and camping areas and an index, glossary and a list of references.

On the whole, this is an excellent publication and I look forward to visiting Brisbane Ranges National Park, book in hand, to locate and identify many of these plants for myself.

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For assistance with the preparation of this issue, thanks to Maria Belvedere and Karen Dobson (label printing), Dorothy Mahler (administrative assistance) and Michael McBain (web page).

Field Guide to the Orchids of New South Wales and Victoria Second Edition

by Tony Bishop

Publisher: *University of New South Wales Press, Sydney, 2000*
344 pp., incl. 72 colour plates. RRP $37.95

'Field Guide to the Orchids of New South Wales and Victoria 1996', will be well known to orchid enthusiasts. It is quite simply the best available, complete field guide to the orchid species found in South Eastern Australia. The second edition has been updated by David Banks, John Keller and John Riley. Two main revisions have occurred. In the first edition, Tony Bishop covered a number of species that had not been formally described. Since his death, many of these have been described and named. For example, the lovely spider orchid I first admired last October is described, in the first edition on p.149 as *Caladenia sp. Aff. reticulata (Dalyenong)*. It is now listed as a full species, *Caladenia cruciformis*, 'distinguished by its rigid cross-shaped crimson flowers with clubbed sepals'. Secondly, the genus *Dendrobium* has been split into two genera, *Dendrobium* and *Dockrilla*. The descriptions and key reflect these changes. However, for the general user, the revisions could be considered relatively minor. The book remains compact and easy to carry on field trips, although the paper used in the second edition is a poorer quality than that of the first.

For those who are unfamiliar with it, 'Field Guide to the Orchids of New South Wales and Victoria', is divided into three main sections. The first contains detailed information for each species of orchid, systematically covering distribution and habitat, identification, similar species and field notes. These descriptions are arranged by botanical affinities, not alphabetically. The second section contains over 500 high quality colour photographs of all taxa described. An index to the colour plates gives specimen location and photographic credits. Finally there is a comprehensive key to the orchid genera and species of New South Wales and Victoria. The book also contains a glossary and index.

The photographic work, mainly by Tony Bishop, is outstanding. The photographs are close ups, mostly taken by flash in situ, and especially selected to aid identification. The standard and consistency is awesome. I checked on the illustrations of two orchid genera difficult to identify because of their small size, Midge Orchids *Genoplesium*, and Onion Orchids *Microtis*, and they are wonderfully clear and sharp. Only one new photograph, a superb illustration of the Long-tailed Greenhood *Pterostylis woolsii*, with its 10-15cm long lateral sepals, is included in the second edition. A continuing frustration is that the illustrations are still not named in the new edition. They are linked back to the text only by a number, requiring a certain amount of flipping back and forth.

At a list price of $37.95 this volume is a 'must buy' for all orchid lovers, botanists, bushwalkers, and field naturalists. However, many who already own the book will probably not immediately update to a second edition of what is substantially the same work.

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Native Orchids of Southern Australia: A Field Guide

by David and Barbara Jones

Publisher: *Bloomings Books. 37 Burwood Road, Hawthorn, Victoria 3122.*
272 pp., 275 full colour photos. RRP $29.95

The introduction to 'Native Orchids of Southern Australia' states, 'This book presents a sample of the native orchids which occur naturally south of latitude 27°S. This line passes close to Brisbane on the east coast of Australia, and Kalbarri on the west. Approximately one-third of the indigenous orchids found in this region are included.' Unusually, this means that orchids from Western Australia and South Eastern Australia are grouped together. The authors' aim, explained in the Preface, is to produce 'a simple field guide to introduce these special native plants to a wide audience'.

I will say at the outset, 'Native Orchids of Southern Australia' has some difficulty fulfilling its stated aim, because, although published as a field guide, it covers only one third of possible species. Size and cost are constraints, but anyone more than a casual user would find this book inadequate as a single field guide to the orchids of Western and South Eastern Australia. This is an obvious criticism that will limit its appeal, but what are the book's strengths?

David and Barbara's new publication is a handy size and weight for a field guide, and has a simple easy to use structure. A brief introduction covers the basics of orchid ecology. The major part of the book deals systematically with each chosen orchid species. A colour photograph, botanical and common names and a straightforward description are provided. Overall distribution, flowering period, habitat and field notes are covered, and in many cases, differences from similar species are outlined. The field guide finishes with a short glossary, references and a very clearly set out index. The general user would find its alphabetic arrangement of orchid genera very convenient.

As a keen native orchid enthusiast, two things drew me to buy this volume even before I was asked to review it. Firstly, its illustrations. Many are truly mouth-watering and a great aid to learning more about native orchids. The photographs I appreciated most are those showing groups of orchids in their natural bush habitat. Examples include the Leafy Greenhood *Pterostylis cucullata*, the Tall Leek Orchid *Prasophyllum elatum*, and the Red Beaks Orchid, *Pyrorchis nigricans*. I wish more publications would include such gems. I was also fascinated by the excellent photographs of the Western and Eastern Underground Orchids *Rhizanthella gardneri* and *R. slateri*.

In some cases an accessory photograph taking in leaves, stem, or from a different perspective is also included. The main photographs of the Channel Leaf Cymbidium *Cymbidium canaliculaltum*, and the Sweet Cymbidium *C. suave*, actually show the dense clumps of green pseudobulbs attached to trees. The flower racemes are only shown in the smaller, inset photograph. I have never seen these orchids and such a treatment really helps me to understand how they would appear in the bush.

Secondly, I was drawn to the book's wide coverage. I have not yet had much opportunity to seek out orchids interstate, and want to be exposed to orchid genera and species I cannot see in Victoria. Such a book allows less experienced orchid enthusiasts, such as myself, to learn without being overwhelmed, as might happen with a larger volume.

I believe then that 'Native Orchids of Southern Australia: A Field Guide' does, to a great extent, fulfil its purpose.

In comparison with native birds there is still very little literature covering Australia's magnificent native orchids. It is such a pleasure to welcome not just one, but two new publications. In their different approaches they will enable both the expert and the beginner to extend their knowledge of these unique plants.

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George Anthony Thomas, B.Sc., Ph.D. (Melb.)

30 June 1921 – 13 November 2000

Dr George Anthony Thomas loved and had a great respect for the natural world. It is therefore not surprising that he joined the Field Naturalists Club of Victoria, at an early age (on 10 August 1942) and went on to become an honorary member. *The Victorian Naturalist* was an important part of his library and was read with great interest.

George was born in Northcote in 1921. He was the eldest of six children (sisters Shirley, Valda and Patricia, brothers Kenneth and Warren) born to his father, George, and his mother, Dorothy McMahon. The family lived in Clifton Hill. George's interest in nature, in particular geology, began with his childhood rambles, complete with dogs in tow, up and down the banks of the Merri Creek. He was quick to notice the massive layers of (Quaternary) basalt overlying the obviously different older (Silurian) rocks beneath.


The young geologist George Thomas in 1952, shortly after joining the Bureau of Mineral Resources.

He attended St. John's Primary School, Clifton Hill and St. Thomas's Christian Brothers Secondary School, Fitzroy before achieving a place at St. Kevin's College in Toorak to undertake his Leaving Certificate. However, the aftermath of the Great Depression was still widely felt throughout the community and George, well aware of the scarcity of the necessities of life and his parents' position, left school to work as a copyboy for *The Herald* newspaper. Nevertheless, George never gave up his love of reading, learning and science and he enrolled part time at the Austral College in Collins Street (Melbourne) in order to complete his Matriculation Certificate. He was later to take up a junior position at the National Museum of Victoria.

In 1940, George gained a place at the University of Melbourne where he commenced a science degree with major studies in Geology and Zoology. On the 16 June 1945, during the King's Birthday weekend, he married a fellow geology student, Nancy Mary Fenwick-Barbour, at St Patrick's Cathedral, East Melbourne.

This was the time of the Second World War and, as a student, George was a corporal in the Melbourne University Rifles. His father, a veteran of the First World War's Western Front, advised George that an officer's life was preferable. The National Museum of Victoria had a use for George until 1944 when he enlisted in the Royal Australian Air Force as Pilot Officer George Thomas. With his background in Geology, he was drawn into the new area of Operational Research on such tasks as air photo interpretation. He then took part in the Allied invasion of the island of Borneo.

After the War, new opportunities in Geology resulted in George joining the Commonwealth Bureau of Mineral Resources (BMR), Geology and Geophysics in 1948. George, Nancy and new daughter Marianne moved to Canberra in 1949 and son Paul was born in 1951.

On joining the BMR, George commenced field work in the Carnarvon Basin, Western Australia under the leadership of Curt Teichert for 'a couple of weeks'. The 'couple of weeks' became 5 months! Communications were limited in such a remote region and so it was that George and half the Western Australian outback heard the news of Marianne's first tooth courtesy of the Royal Flying Doctor's radio network.

George further developed his interests in fossils during the field seasons in the Carnarvon, Canning and Bonaparte Basins of the West. In particular, fossil brachiopods from the Devonian to Permian were to capture his imagination. He enrolled for a Ph.D. at the University of Melbourne and spent time at the University in the mid 1950s, graduating in 1961. He joined the staff of the Department of Geology at the University of Melbourne in 1960 and was a Senior Lecturer in that department until his retirement.

In 1960 George, Nancy and family returned from Canberra to live in North Melbourne and then Ivanhoe. The family continued to grow with the arrival of Peter and then Michael and Andrew.

George's geological work, covering such areas as field work and mapping, stratigraphy and palaeontology, is preserved in a range of monographs and articles. It is characterised by meticulous detail and significant discoveries. Amongst the latter were the discovery and proving on palaeontological grounds of the existence of an Early Carboniferous succession in the Canning Basin and the palaeontological proof of a Late Permian Tatarian (or Wuchiapingian in current terms) succession in both the Canning and Bonaparte Basins. These and other significant discoveries, which have had major impacts on Late Palaeozoic Gondwanan and global correlations, are to be found in the published literature. George himself, with characteristic modesty, never trumpeted his achievements.

Dr. George Thomas in 1999. Photos kindly supplied by Mrs. Nancy Thomas.

George, often with his family, travelled widely to Europe (including the then USSR), India, Asia and the Americas. These travels extended his range of geological friends but were also opportunities to extend his wide cultural and historical interests. George's broad interests, and knowledge, were vast as testified by a glance at the library in the family home at Ivanhoe. Lengthy discussions would range through philosophy, religion, and fine art, to subtleties of American Civil War History. However, above all, he was a family man and a true gentleman. His was a life to celebrate and he shall be greatly missed by Nancy, his family and all who knew him.

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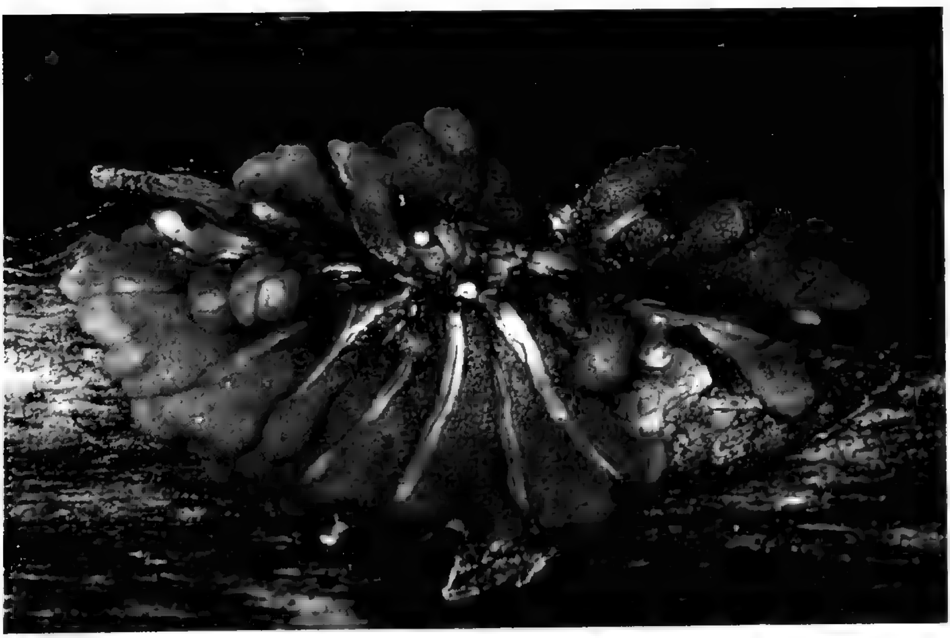
A. *Nyctalis mirabilis*. The Beeches. Photo: Bruce Fuhrer.

B. *Dictyopanus pusillus*. Mt. Kembla. Photo: Pat Jordan

C. *Battarraea stevenii*. Victoria. Photo: Bruce Fuhrer.



D. *Hypocreopsis* sp., Nyora. Photo: Ilma Dunn

PLATE 4

A. *Anthurus archeri*, Michelago Peak. Photo: Margery Smith.

B. *Calostoma rodwayi*, Otways. Photo: Ian McCann.

PLATE 5

A. *Amanita phalloides*, Melbourne. Photo: Virgil Hubregtse.

B. *Rozites roseolilacina*, Grampians. Photo: Ian McCann.

PLATE 6

A. *Aleuria rhenana*, Dom Dom. Photo: Sheila Houghton.

B. *Dictyophora indusiata*, Innisfail. Photo: Bruce Fuhrer.

C. *Bankstamyces macrocarpus*, Kurth Kiln. Photo: Ilma Dunn

D. *Craterellus cornucopioides*. Photo: Anneke Veenstra-Quah.

The Victorian Naturalist

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A Large Weevil from the Simpson Desert

During a trek through the southern part of the Simpson Desert, west of Poeppel Corner, in July 1999, we crossed a number of salt lakes. These lakes form a prominent feature of the area and have a hard, dry crust (Fig. 1).

To my surprise members of our group found two large, dead weevils encrusted in the hard salt surface of two of these lakes and then, further east on another dry salt lake, a live specimen was found crawling sluggishly on the surface some distance from the edge of the lake.

The live Weevil was black with grey markings and heavily sculptured. One of the most interesting things was that the elytra (wing cases) were fused together, i.e. the weevil was flightless. Fusion of the elytra forms a protective shell for the abdomen and reduces moisture loss in the harsh conditions. The total length of this beetle was 35 mm, and was known to the group leaders as the 'Elephant Beetle' because of its prominently large rostrum (snout).

Since baggage was limited to one kitbag, I was unable to carry Zimmerman's 8-volume series on weevil identification and had to wait until my return to Melbourne. Fortunately, the specimens travelled well and one was photographed before the identification (Fig. 2). The identification was done using the dead beetles, the live one having been released in the desert after careful study. It was fortunate that Mr Bob Thompson, a weevil expert, was working at the Museum of Victoria and was kind enough to attempt the identification using E.C. Zimmerman's *Australian Weevils* (CSIRO Australia), and specimens from the MOV collections.

The weevils were identified as belonging to the sub-family Leptopiinae (Curculionidae) and most likely the species *Leptopius* (near) *gravis*. This sub-family is distinguished by a conspicuous scar on the outer surface of each mandible left by the detachment of a tooth used by the adult when escaping from the pupae (Lawrence and Britton 1994). Larvae of most species of *Leptopius* live in the soil and feed on the roots of wattles (Moore 1980) and, according to 'The Insects of Australia' (CSIRO 1970), on 'roots and foliage of *Acacia*'. The wattle species seen near these salt lakes were Dune Wattle *Acacia ligulata*, Victoria Wattle *A. victoriae*, Mulga *A. aneura* and Gidgee *A. cambagei*.

Fig. 1. Salt Lake in the Simpson Desert.

Fig. 2. The weevil *Leptopius* (nr.) *gravis* found on the lake surface.

The reason why these beetles were walking on the salt lakes remains to be explained.

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Cover: Little Penguins *Eudyptula minor* arriving ashore at night after spending the day feeding at sea. See story on page 76. Photo by Scancolor Australia Pty. Ltd. and supplied by Peter Dann.

Our web page: http://calcite.apana.org.au/fncv/vicnat.html
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The Distribution and Abundance of Little Penguins at Sea in Western Port, Victoria

Peter Dann[1], Ros Jessop[1] and Marg Healy[1]

Abstract

The main aim of this study was to describe the patterns of distribution and abundance at sea of the Little Penguin *Eudyptula minor* in Western Port. Penguins were counted along an 81 km series of transects from a boat at approximately four-weekly intervals between April 1991 and August 1994. The mean number (± s.e.) of penguins seen per survey was 61.7 ± 10.4. Total numbers per count ranged from 0 to 214. Higher numbers of penguins were found in late autumn and winter and lower numbers in mid and late summer. In April 1994, when the number of penguins was greatest (214), we estimated that the total number of penguins in the bay was 383. Similarly, the mean for all counts (57.4) gave an estimate of 103 birds. This estimated maximum number was 1.5% of the estimated breeding population on the Summerland Peninsula.

Penguins were located mainly in the western and northern arms of the bay. Relatively few birds were seen in the shallower eastern arm and none over intertidal areas. The highest numbers of penguins per kilometre of transect were found along two transects in the centre of the bay at the confluence of the western, northern and eastern arms. Group sizes were small, 49% of 884 groups consisted of single birds and 94% of groups consisted of five birds or fewer.

Finally, the distribution and seasonal occurrence of Little Penguins in Western Port are discussed in relation to penguin movements and the biology and ecology of the fish species eaten by penguins.
(*The Victorian Naturalist* **118** (3), 2001, 76-81.)

Introduction

The distribution and abundance of birds at sea in Victorian waters are not well known. Learmonth (1966) gave some details of the occurrence of seabirds in western Victoria, as did Wheeler (1981) for Phillip Island, Simpson (1972) for Bass Strait and Norman (1992a, b) for waters south of Phillip Island. Some studies have considered seabirds in enclosed waters such as Port Phillip Bay (Pescott 1983; Norman 1992a, b) or surveyed the distribution and abundance of seabirds at breeding sites along the coast (Harris and Norman 1981).

Previous studies of birds in Western Port have been land-based and consequently concentrated on the waterbirds, waders and the few seabird groups such as cormorants, gulls and terns that congregate at roosting sites at high tide (Dann *et al.* 1994; Loyn *et al.* 1994). To examine the distribution of those seabirds which are less dependent on land, such as penguins, it is necessary to conduct surveys from boats at regular intervals and in a systematic fashion. The main aim of this study was to describe the patterns of distribution and abundance at sea of one locally breeding and abundant seabird, the Little Penguin *Eudyptula minor*, in Western Port between April 1991 and August 1994.

[1] Phillip Island Nature Park, PO Box 97, Cowes, Phillip Island, Victoria 3922.

Methods

Western Port lies on the southern coast of Victoria, east of Melbourne, and covers 680 km^2 including 270 km^2 of tidal mudflats. It has a coastline of 263 km of which 107 km are lined by White Mangroves *Avicennia marina* (Shapiro 1975). One large island (Phillip Island) lies in the southern entrance and a larger island (French Island) occupies the centre of the bay (Fig. 1).

Thirty-six surveys were completed in the 40 months between April 1991 and August 1994. Boat engine failure and inclement weather caused four counts to be abandoned or postponed and prevented our attempts to maintain four-weekly intervals between counts. Little Penguins were counted along an 81 km series of transects (Fig. 1) from a boat travelling at 20-25 knots. The transects were perpendicular to the main channels to cover the entire range of sub-tidal water depths in each section of the bay. Intertidal areas were not traversed and subtidal areas less than two metres deep at high tide were also not counted with the exception of those areas in the eastern part of the Bay (Fig. 1).

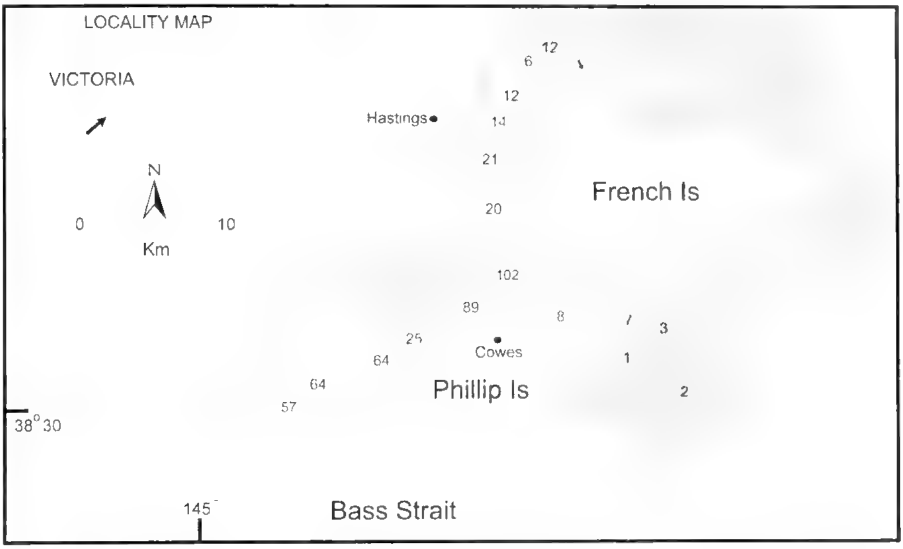

Fig. 1. The series of transects (black lines) used to count Little Penguins in Western Port and the total number of penguins per kilometre counted on each transect in Western Port. The shaded areas are those less than two metres deep at high tide and include all intertidal areas and some shallow subtidal areas. The small arrow north-west of French Island indicates the approximate position of Barrilliar Island.

Usually two observers were stationed on either side of a seven-metre boat (eye height c. 3 m) and counted penguins in the right-angled sector from the bow to starboard or port. Observers recorded each penguin seen up to 500 m from the boat onto a tape cassette. When counting accuracy was impaired by either choppy sea conditions or larger numbers of penguins, the boat was stopped briefly while the counts were made. The observations made each time a penguin was seen included the time, transect, number of individuals and behaviour at the time. Difficulties of visibility caused by weather (Tasker *et al.* 1984) were reduced by only counting on days with wind speeds of less than 10 knots. The counts usually took five hours and were carried out around the middle of the day and, when possible, within a few hours of high tide. Identifications were made using 8 × 40 binoculars.

Total counts in the bay were compared with the monthly mean numbers of penguins coming ashore at Summerland Beach, Phillip Island and the total numbers of penguins with eggs or chicks in burrows. Penguins were counted for 50 minutes from the time of first arrival each night as they crossed Summerland Beach under lights at the Penguin Parade. Approximately 60% of birds coming ashore each night have done so by the end of this period (Montague 1982). The breeding data were collected during two-weekly visits (and combined in monthly samples) to c. 55 burrows at two sites on the northern side of Summerland Peninsula on Phillip Island (see Dann *et al.* 1995 for more details of data collection).

Results

A total of 2224 penguins was recorded on the 36 counts. The mean number (± S.E.) of penguins seen per survey was 61.7 ± 10.4. Total numbers per count ranged from 214 (April 1994) to 0 (June, November 1991 and February 1994) (Table 1). Greater numbers were found from mid-autumn to early winter in most years (April to June 1991, April to July 1992, April and May, 1993 and March to May 1994) and occasionally in late spring and early summer (October and December 1992 and September and November 1993) (Fig. 2).

Comparisons of total counts in the bay with monthly means of penguins coming

Table 1. Numbers of penguins counted each month between April 1991 and August 1994. nc – not counted.

	1991	1992	1993	1994	Mean
Jan		11	13	12	12
Feb		19	20	0	13
Mar		21	10	78	36.3
Apr	202	66	81	214	140.8
May	105	181	89	138	128.3
Jun	118	52	nc	24	64.7
Jul	15	52	48	nc	38.3
Aug	5	nc	53	14	24
Sep	nc	2	121		61.5
Oct	22	183	28		77.7
Nov	0	4	126		43.3
Dec	9	88	nc		48.5

ashore at Summerland Beach on the southern shore of Phillip Island showed no significant correlation ($r = 0.31$, $df = 34$, $p > 0.05$). Similarly there was no significant relationship found between the counts of penguins in Western Port during the breeding period and the number of penguin burrows on Phillip Island containing eggs or chicks ($r = 0.09$, $df = 18$, $p > 0.05$). The absence of correlations between these variables suggests that the number of birds using Western Port is not related to attendance patterns or breeding activity on Phillip Island.

We attempted to estimate the total number of penguins frequenting Western Port by calculating the percentage of the bay covered by the counts and, assuming that the penguins were distributed in a representative manner on the transects, extrapolating from the mean and maximum counts accordingly. We also assumed that there were no penguins in the shallow parts of the bay and that the field of view was 500 m on either side of the transect. Both of the latter of these assumptions were tested in the field and found to be valid. No penguins were seen during extensive searches over intertidal areas of the bay at high tide on the first two surveys suggesting that these areas were not important feeding areas for penguins. In addition we experimented with penguin-sized objects floating on the sea's surface and found that these could be seen up to 500 m from the boat providing wind speeds were less than 15 knots. Calculated in this manner, we estimated that the total counts covered 55.8% (81 km^2) of the area of the bay judged as likely to be frequented by penguins (145.2 km^2). In April 1994, when the number of penguins counted in the bay was greatest (214), we estimate that the total number in the bay was 383 ($214 \times 100/55.8$). Similarly, the mean for all counts (57.4; Table 1) gave an estimate of 103 birds.

The seasonal pattern of penguin abundance in Western Port is illustrated by the monthly means of all counts (Fig. 3). Higher numbers of penguins were found in late autumn and winter and the lowest means were in mid and late summer.

The penguins were located mainly in the western and northern arms of the bay (Fig. 1). Relatively few birds were seen in the shallower eastern arm and none over intertidal areas. The highest numbers of penguins per kilometre of transect were found along two transects in the centre of the bay at the confluence of the western, northern and eastern arms (Fig. 1).

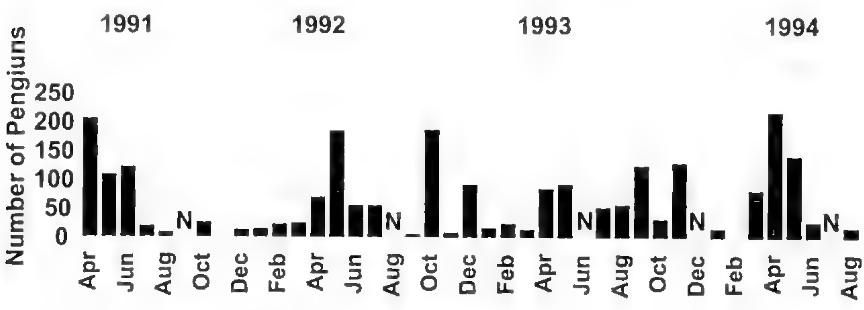

Fig. 2. The total numbers of Little Penguins counted each month in Western Port between April 1991 and August 1994. N denotes missing counts.

Table 2. Group sizes of Little Penguins recorded at sea in Western Port.

Group Size	Number of Groups	%
1	437	49.4
2	194	22.0
3	117	13.2
4	57	6.5
5	27	3.1
6	12	1.4
7	7	0.8
8	6	0.7
9	2	0.2
10	7	0.8
11	2	0.2
12	5	0.6
13	0	0
14	2	0.2
15	1	0.1
16	0	0
17	1	0.1
18	0	0
19	0	0
20	1	0.1
23	1	0.1
25	1	0.1
31	1	0.1
35	1	0.1
40	1	0.1
112	1	0.1
Total	**884**	**100**

Group sizes were small, 49% (437) of 884 groups consisted of single birds and 94% of groups consisted of five birds or fewer (Table 2). In October 1992, 112 birds were observed in one group feeding with terns and gulls at the confluence of the northern and western arms but groups of 20 birds or more were seen on only seven occasions.

Penguins were seen feeding in conjunction with terns and gulls on a number of occasions and these aggregations appeared to be associated with large schools of baitfish. Fig. 4 is an echosounding trace taken where penguins and Crested Terns *Sterna bergii* were feeding together and shows schools of baitfish that have apparently been driven to the surface by predatory fish (Frank Hoedt, *pers. comm.*) and hence made available to feeding seabirds.

Over the past 25 years there have been many reports of penguins on and around Barriliar Island to the north-west of French Island (Bird Observer's Club of Australia-Western Port Survey, *unpubl. data*). In March 1993 we visited the island and found one penguin chick almost at fledging age in one burrow, and one moulting adult in another. Two other empty burrows appeared to be in regular use. A second visit in March the following year revealed a similar number of burrows in use. This small group of breeding birds (probably eight in total) presumably accounted for the small number of penguins occasionally seen at the top of the north arm.

Discussion

Significance of Western Port for Little Penguins

These surveys and recent radio-tracking studies (Collins *et al.* 1999) have shown that more penguins feed in Western Port than previous studies suggested. For example, none of the 67 penguins from Phillip Island that had been followed by radio-tracking between 1986-87 went into Western Port (Weavers 1992). This may have been because the birds that were radio-tracked by Weavers came from the southern side of the Summerland Peninsula rather than the northern side that faces Western Port (Dann *et al.* 1992). Similarly, none of the 413 penguins that were banded (with individually numbered flipper tags) on Phillip Island between 1968 and 1988 and found dead away from the Island, was found inside Western Port (Dann *et al.* 1992). Most of the shores of Western Port are mangrove-lined with

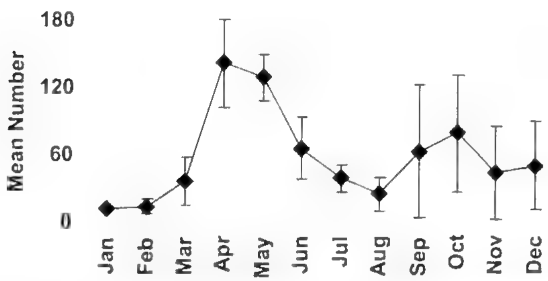

Fig. 3. The mean numbers (± S.E.) of Little Penguins counted each month in Western Port between April 1991 and August 1994.

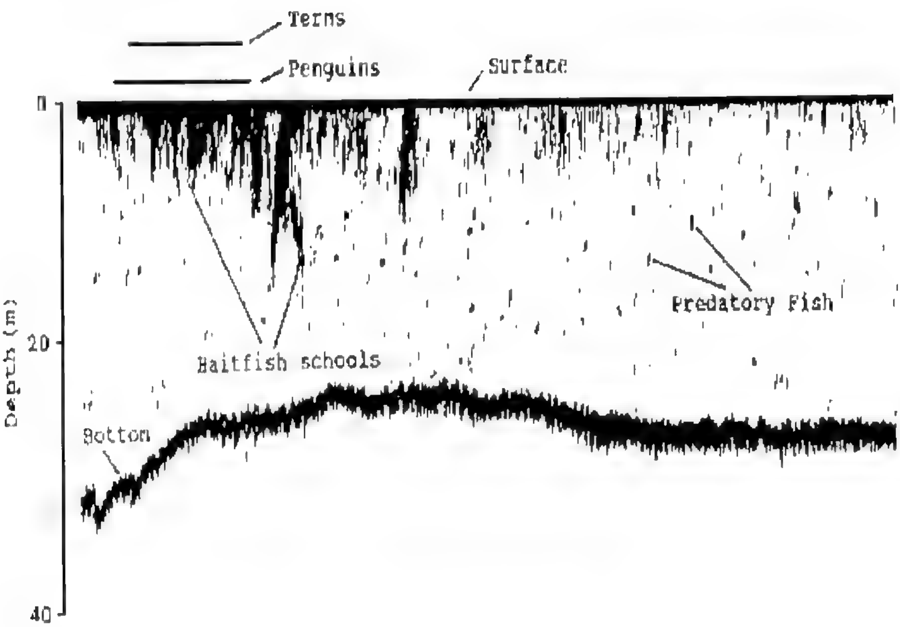

Fig. 4. An echosounding trace of baitfish schools that have been driven to the surface by predatory fish. The lower of the two horizontal lines above the sea surface represents where penguins were observed feeding in relation to the baitfish schools and the higher, Crested Terns *Sterna bergii*. Diagram and interpretation provided by Frank Hoedt.

extensive intertidal mudflats (Shapiro 1975) and it may be that beach-washed penguins (the major source of band recoveries away from Phillip Island) are rarely discovered in these areas.

The largest number of penguins using Western Port during this study was estimated to be 383 and the mean for all the estimates was 103 penguins. It is estimated that there are approximately 24-28,000 breeding penguins on Phillip Island (Mike Cullen, *unpubl. data*). Using the middle of this range (26,000), the estimated maximum number of birds in Western Port (383) was 1.5% of the breeding population on Phillip Island.

Distribution in Western Port

The western arm, and to a lesser extent, the northern arm, were the more important feeding areas for penguins in Western Port. Both this survey and radio-tracking studies (Collins *et al.* 1999) have highlighted the importance of the western arm to penguins in autumn, a reflection in part of the proximity of this part of the bay to the breeding colony. The high numbers per kilometre in the central part of the bay suggest that the availability of food may have been higher there. It may be that the mixing of different water masses at the confluence of the three arms of the bay creates conditions favourable to the prey species of penguins. The convergent fronts associated with tidal plumes have been identified as physical processes that may enhance seabird foraging (see Hawke 1996 and references therein). By contrast to penguins, observations of Australian Fur Seals *Arctocephalus pusillus* were fairly evenly spread throughout the bay and Bottlenose Dolphins *Tursiops truncatus* were found more frequently at the two entrances to Bass Strait (Dann *et al.* 1996).

The group size of penguins in Western Port showed some similarity to that reported for penguins seen at sea in Port Phillip Bay (Norman 1992a). In this study, 94% of groups consisted of five birds or fewer, and in Norman's (1992a) surveys, 93.7% of groups consisted of five birds or fewer (calculated from his Table 5). However twice as many birds were solitary in this study.

Seasonal occurrence of penguins in Western Port

Peak numbers occurred in April and May and lowest numbers in January and February. Brager and Stanley (1999) found peaks in abundance of White-flippered Penguins *Eudyptula minor albosignata* in inshore waters around the Banks Peninsula in New Zealand in autumn and spring also but had no information on prey abundance or distribution for comparison. Peak numbers of penguins in Western Port coincided with the latter part of the seasonal occurrence of juvenile pilchards and anchovies in the bay in late summer and autumn (Hoedt *et al.* 1995). The food supply of penguins between spring and autumn may be largely dependent on the appearance of spawning adult fish near Phillip Island (Cullen *et al.* 1992; Hoedt *et al.* 1995) and the subsequent pulse of young recruits (late summer and autumn) hatched from the spawning. The increased use of Western Port by penguins in autumn may be caused as much by the depletion of adult fish outside the bay as the arrival of juvenile fish inside the bay and hence not precisely reflect the timing of the latter event.

Acknowledgements

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New Tanjilian Fossil Localities at Dungaree Creek, Central Victoria

Clem Earp[1]

Abstract
Forestry work in the Matlock district, central Victoria, Australia, has temporarily revealed two new fossil localities in the Norton Gully Sandstone, Walhalla Group, of Pragian-Emsian (Early Devonian) age. The fauna, a 'Tanjilian' marine fossil assemblage of *Panenka* bivalve molluscs, dacryoconarids, and orthoconic nautiloids, is briefly described, and a summary of relevant literature is given. From qualitative and quantitative observations of the sedimentology, it is concluded that the fossils are allochthonous and were deposited by turbidity currents, with no sign of reworking by storm wave action. (*The Victorian Naturalist* **118** (3), 2001, 82-88.)

Introduction

The term 'Tanjilian' was coined by Chapman (1914, 1926) as a tentative name for a rock series characterised by a small set of distinctive fossils. The first of these had been described by McCoy (1879) from the Tanjil goldfield in west Gippsland. This location was lost and Gill (1941) renamed the series 'Jordanian', claiming that it did not occur in the Tanjil area at all.

Thomas (1953) reported the rediscovery of the original location, but further geological mapping has made the term obsolete as a stratigraphic name. The name now seems restricted to a subset of Chapman's original group of fossils, which form a distinctive assemblage in a Lower Devonian marine formation, the Norton Gully Sandstone unit of the Walhalla Group (VandenBerg 1975).

A Tanjilian assemblage typically contains three types of fossils:

- bivalve molluscs, usually belonging to the genus *Panenka*, although a few other genera are known;
- dacryoconarids, small conical-shelled planktonic animals, referred to in older literature as tentaculites and pteropods;
- orthoconic (straight-shelled) nautiloids.

Brachiopods, so characteristic of the Victorian Devonian, do not occur in the assemblage but are common enough in other horizons of the Norton Gully Sandstone. Conversely, the Tanjilian species seldom occur outside this assemblage. A notable exception is the occurrence of the Tanjilian dacryoconarid *Nowakia* in limestone at Tyers River (Cooper 1973).

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Dungaree Creek fossil localities

The Warburton-Woods Point road closely follows the old Yarra Track after it passes Monty's Camp 70 km east of Warburton. The area contains several important Palaeozoic fossil localities, among which may be mentioned the 19-Mile Quarry (type locality of *Baragwanathia longifolia*; Lang and Cookson 1935), Mt. Matlock (Ordovician and Silurian graptolites; Harris and Thomas 1947), and Frenchman Spur (Early Devonian plants; Tims and Chambers 1984).

The road runs along the crest of the Great Dividing Range at an altitude of 1000 m. The district is unpopulated, hilly, and covered almost completely by a forest of Alpine Ash *Eucalyptus delegatensis* with an undergrowth of *Acacia* and *Coprosma* species and Blanket Leaf *Bedfordia arborescens*. The bush and a soil cover of up to 2 m mean that rock exposures are limited solely to areas of human disturbance, such as roads and former building sites.

In 1994 I noticed a new logging track which did not appear on any maps (Fig. 1). It is 1.2 km east of Fehring's Clearing, and branches northwest off the main road just past where the road crosses the head of Dungaree Creek. The track follows a ridge for about 0.75 km, then emerges into a burnt clearing (now overgrown).

Bedrock is first exposed about 0.4 km along the track, on the ridge separating Dungaree and Oaks Creeks. For the next 0.3 km, the strata are visible in the surface of the bulldozed track, dipping 75° west and striking 135°. The rock is weathered and relatively soft, and consists of yellow

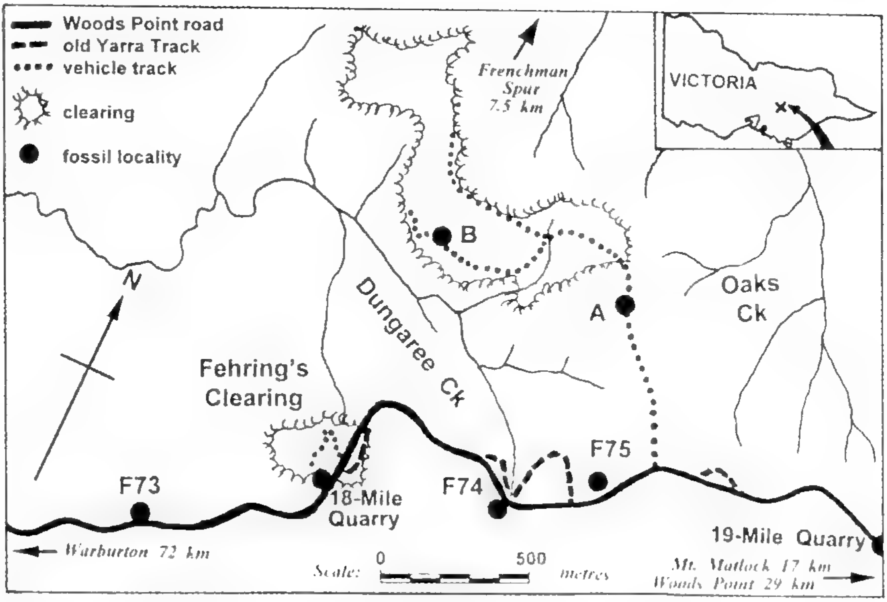

Fig. 1. Locality map, Dungaree Creek area. Fossil localities: A, B - this paper; F73, F74, F75 - spot localities of Moore (1965); 18-Mile Quarry and 19-Mile Quarry according to Geological Survey of Victoria (Talent 1968). Map drawn from aerial photograph (1995) supplied by Qasco Pty. Ltd.

and black thin-bedded claystone, siltstone, and fine to coarse sandstone.

At one particular point, designated location A (Fig. 1), loose blocks of the bedrock have been unearthed, and coarser material is evident. Sandstone, weathered pink and yellow, is interbedded with the finer sediments, and all contain abundant comminuted plant fragments. Most are preserved as mineralised impressions, but some coalified remains were found. A single sandstone block was found to contain a typical Tanjilian fauna.

At a fork in the track, a low cutting exposes red sandstone speckled with mica. The west branch of the track is bulldozed out of the thick soil cover, which contains loose stone blocks. In the area where this branch of the track turns to the northwest, the blocks are a silvery sandstone, in which mica is the main component. The bedding planes in these blocks are crowded with comminuted plant impressions, but because of the lack of mineralisation or remnant carbon, and the coarseness of the medium, none are identifiable. The source of the mica is unknown; possibly the material is reworked from older sedimentary rocks.

Further on, the track winds round the side of a small valley, and the area is heavily churned by logging machinery. Loose blocks of graded coarse sediment contain well-rounded quartz particles ranging up to small granule size (2 mm diameter). The only in-place exposure is thin-bedded grey mudstone; the dip and strike indicate hillside creep. On the side of the hill near here were found loose blocks of yellow and grey thin-bedded claystone to sandstone containing a well-preserved Tanjilian assemblage; this is designated location B (Fig. 1).

A collection in the Museum of Victoria, made by G. Bell near Mt. Duffy almost exactly 20 km north of Dungaree Creek, shows precisely the same lithology and fossil assemblage as location B.

Previous studies

The references cited previously are all relevant to the general Yarra Track area. A useful list of all the early fossil localities has been compiled by Bell (1956). However, faulting is present, and sudden lithological changes occur, so that the particular interval of rock observed at Dungaree Creek is very unlikely to be the

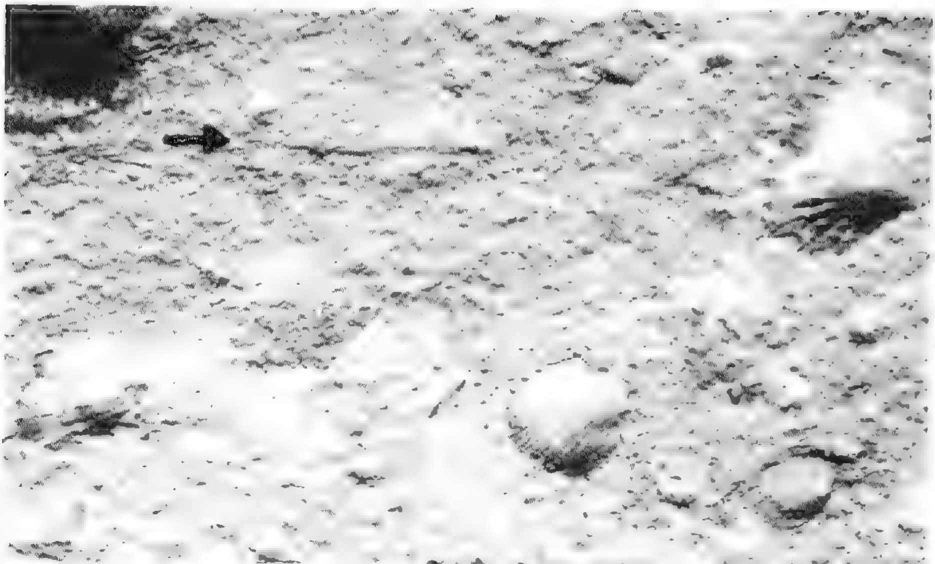

Fig. 2. Oriented moulds of *Panenka planicosta* shells and a dacryoconarid (arrowed) at the base of a sandstone turbidite layer. Location B, ×4.5. The arrow points down current.

same as that at 19-Mile Quarry or Frenchman Spur, for example.

Gill (1941) listed a number of fossil localities in the area. At the closest of his localities, the 18-Mile Quarry, he recorded the typical Tanjilian assemblage of bivalves (*Panenka gippslandica*), dacryoconarids (*Styliolina fissurella* and '*Tentaculites*') and orthoceratid nautiloids, as well as the plants *Zosterophyllum australianum* and *Hedeia corymbosa*. The dacryoconarids were re-examined by Boucek (1968, as 'locality 60216'), who identified several other taxa, but some of these were disputed by VandenBerg (1975). Recent revisions of dacryoconarid species have altered many of these identifications (Alberti 1988, 1993, 1995, 1997, 1998).

Moore (1965) attempted a detailed description of the area from Warburton to Woods Point, but his observations were limited to road cuttings and his stratigraphy is regarded as unreliable (VandenBerg 1975). His record of fossils from his location F75, which he equates with the 18-Mile Quarry, includes Gill's earlier collection, with the addition of the bivalve *Panenka planicosta*. Also from this location, and from two others nearby (F73 and F74, see Fig. 1), Moore added '*Hostimella*', and 'plant remains indet.', terms which are really synonymous. It is important to note that the location shown on Moore's map for the 18-Mile Quarry does not match that on the later Geological Survey maps (Talent 1968; VandenBerg 1975; Fig. 2).

The area was more closely examined towards the early 1970s in connection with the Thomson Dam scheme. Talent (1968) emphasized the importance of allowing for considerable hillside creep when measuring dips and strikes. Tapp's thesis (1970) largely follows Moore. VandenBerg's preliminary stratigraphy (1971) contains some interesting sections; some of the nomenclature was published (VandenBerg and Schleiger 1972). The definitive stratigraphy is set out in VandenBerg's final report (1975); this makes it clear that the 18-Mile Quarry and the new exposures all lie in the lower part of the Norton Gully Sandstone.

Palaeontology

Only the fauna is discussed here, as none of the abundant plant remains are identifiable. The fossils of the Tanjilian fauna at Dungaree Creek are represented by moulds, with no calcareous shelly matter remaining.

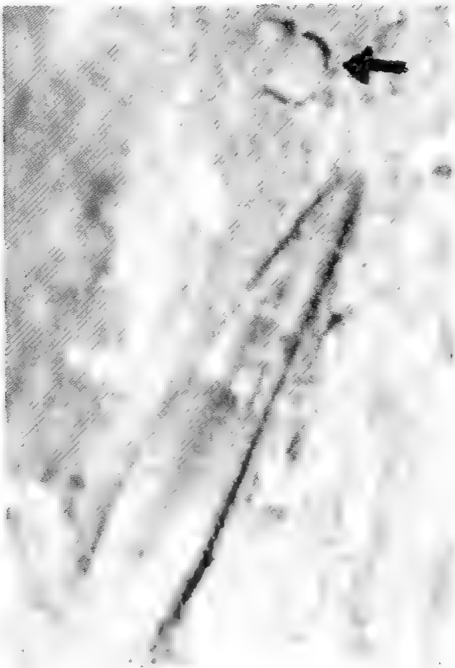

Fig. 3. Crushed mould of one dacryoconarid shell in longitudinal view, and another (arrowed) in transverse view, in shell breccia siltstone. Location B. ×26.

***Panenka* bivalve molluscs**

Phylum Mollusca - Class Bivalvia - Subclass Pteriomorphia - Order Praecardioida - Family Praecardiidae - Genus *Panenka*

Panenka planicosta Chapman 1908

Well-preserved moulds of single valves of this species (Fig. 2) were found at location B. Unlike other Victorian *Panenka*, which have medium to large shells, this species is under 5 mm in diameter. The radial ribs, when viewed under a magnifying glass, have a groove along their length and this distinguishes them from juvenile specimens of the larger species. Members of the genus are said to be deep-water molluscs burrowing shallowly in a soft sea floor (Kriz 1979).

Interspersed among the *Panenka* are poorly-preserved minute smooth shells, up to 0.7 mm diameter. These are presumed to be the spat (juveniles) of *P. planicosta*; the association of smooth juveniles and ribbed adults is similar to other bivalve occurrences (e.g. Pojeta *et al.* 1976, Plate 2, fig. 4). The same small shells are seen at location A without the adults.

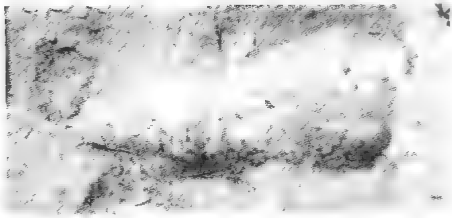

Fig. 4. Poorly preserved mould of the uncrushed apical portion of a nautiloid. Location A, ×2.

Dacryoconarids

Phylum Mollusca - Class Tentaculitoidea - Order Dacryoconarida

The dacryoconarids are fossil remains of small, narrow conical shells (Figs 2, 3), usually appearing in crushed form as narrow isosceles triangles with a prominent longitudinal fracture that was once erroneously thought to be a characteristic of the live animal. As the dacryoconarid animals were planktonic, they spread freely over the mid-Palaeozoic seas, and can be used to correlate and date strata from different continents. Most Tanjilian forms are classed as either styliolinids, with smooth or longitudinally striated shells (Gill 1941), or nowakiids, with prominent transverse rings (Cooper 1973).

Family Styliolinidae - Genus *Styliolina*

Styliolina cf. *fissurella* (Hall)

Smooth-shelled Tanjilian dacryoconarids are assumed to belong to this species, which can be distinguished from the other Victorian styliolinids *Metastyliolina* (with longitudinal ribs) and *Styliacus* (with very narrow shells) (Alberti 1988).

This species of *Styliolina* would, by international comparisons, date the Dungaree Creek localities as Emsian or younger (Boucek 1968), i.e. latest Pragian to Zlichovian in the Bohemian stages. However, the situation is not quite so clear as that. In Victoria, *S. fissurella* has been reported from a wide range of localities (Garratt 1975), often in conjunction with typically Pragian fossils, but ranging down to the base of the Humevale Siltstone at Lilydale, which is supposedly of earliest Lochkovian age. Elsewhere, *S. fissurella* has been reported from Alaska (Churkin and Carter 1970) and Central Asia (Obut 1974) from the same graptolite zones of the Pragian-Emsian as are found in the

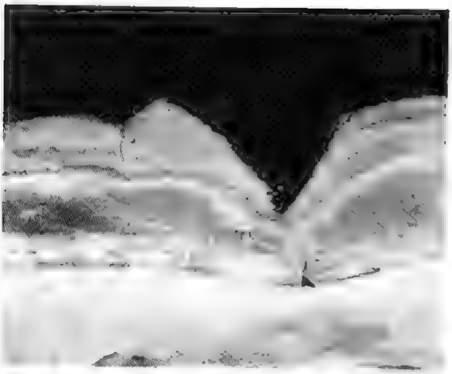

Fig. 5. Transverse section through layers of siltstone and claystone which have been deformed underneath a single detached chamber of a nautiloid shell resting at the base of an overlying sandstone bed (now removed). Location A, ×3.

lower Norton Gully Sandstone. On the other hand, Boucek (1968) suggested that the dacryoconarids from 18-Mile Quarry were much younger: Eifelian (Middle Devonian), as they are in Europe. The difference arises, at least in part, from the nondescript nature of the fossils, which prevents discrimination of taxa from different periods. On account of the association with Pragian fossils, it is preferable to consider the Victorian occurrences as being contemporaneous with those in Alaska and Central Asia rather than those in Europe.

Family Nowakiidae - Genus *Nowakia*
Nowakia ex gr. *acuaria* (Richter)

These are too fragmentary to identify precisely. Moreover, the minute rings have often become very faint, suggesting the possibility that some of the apparent styliolinids are poorly preserved nowakiids. Alberti (1995) considers Tanjilian specimens to be an indeterminable subspecies of *N. acuaria* at lower levels, succeeded by *N. matlockiensis* (Chapman). The age ranges he gives for these species are late Pragian - early Emsian. The specimens from Dungaree Creek belong to the *acuaria* species group, lacking the density of fine rings seen in *N. matlockiensis*.

Orthoconic nautiloids

Phylum Mollusca - Class Cephalopoda
Subclass Nautiloidea - Order Orthocerida - Superfamily Orthoceratoidea - Family Orthoceratidae - Genus *Michelinoceras*
Michelinoceras sp. indet.

Sections of conch found at location A in fine-grained pink sandstone. These show a circular cross-section, empty central siphuncle, and a relatively wide septal separation. The remains are commonly referred to in Victorian literature as '*Orthoceras*', however this genus has long been restricted to a few species of Ordovician age. Modern standards of diagnosis practically rule out any hope of identifying leached-out specimens like these, as most internal structures have been destroyed. The surviving characteristics mentioned above are consistent with the genus *Michelinoceras*, which is, indeed, where many former '*Orthoceras*' species are now assigned.

In contrast to the thin-shelled dacryoconarids, which are mostly crushed, the nautiloid sections are intact (Fig. 4). The pressure of overlying sediments has instead pushed them down a little, slightly distorting the underlying layers (Fig. 5).

Sedimentology

Recent studies of the Walhalla Group, outside the Matlock district, have suggested that the sediments were deposited in relatively shallow water and reworked by storm waves (Weir *et al.* 1988; Dyson 1996). Previously, deep-water turbidity currents were considered responsible for the sedimentation (VandenBerg and Schleiger 1972). Insufficient exposures are available to allow study of purely sedimentary structures at Dungaree Creek, but the appearance of the fossil remains do permit some conclusions to be drawn.

The Tanjilian assemblages occur in two modes: as chaotically arranged three-dimensional shell breccia, and as oriented shells lying on a single plane. Both contain only disarticulated bivalves. Moore (1965) was of the opinion that bands of shelly Tanjilian fossils represented mass mortality episodes caused by turbidity. From the appearance of the *Panenka* it would seem the shells are the transported remains of already disarticulated animals. The association of mineralized comminuted plants and small molluscs resembles the 'dysoxic' facies of Mapes and Mapes (1997), formed by rapid sedimentation at depth.

The shell breccia forms irregular layers

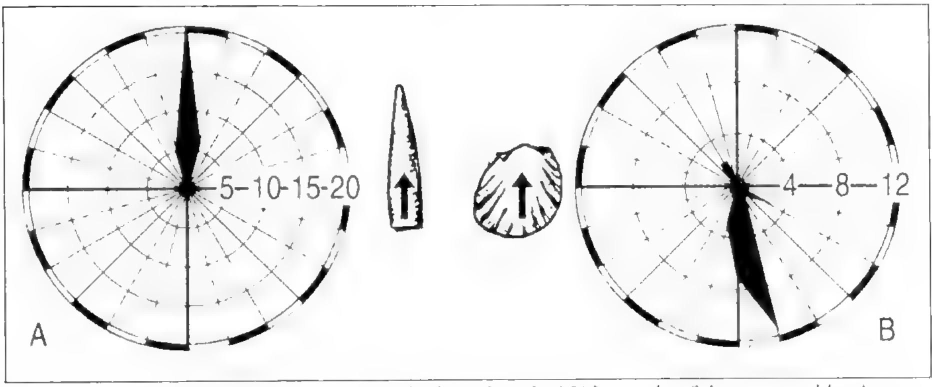

Fig. 6. Rosettes showing the distribution of orientations in 15° intervals of dacryoconarids (A, sample size N=31) and *Panenka* (B, N=27). The orientation conventions used for the measurements are those of Nagle (1967), shown by the arrows with the small drawings of each shell type. From the bedding plane part of which is shown in Fig. 2; as the slab was not in place, absolute directions could not be used; the measurements are relative to the mean orientation direction of the dacryoconarids.

in massive siltstone. *Panenka* valves are oriented at all angles with respect to the bedding and to each other. Dacryoconarids are also oriented at angles to the bedding (Fig. 3), indicating rapid, turbulent deposition (Hladil *et al.* 1996). There are rare tabular rip-up clasts of shale. These observations suggest rapid deposition from a dense turbidity current.

The layers of oriented fossils seem to form at the junction of a breccia layer with an overlying band of fine sandstone, and probably represent reworking of the breccia by current scouring. *Panenka* valves all rest concave side down, and dacryoconarids lie on their sides (Fig. 2). As cleavage is planar at the base of the sandstone, it is possible to measure the longitudinal orientation of the shells using the plastic sheet method (Schleiger 1969). The results are shown diagrammatically in Fig. 6, and may be compared with the classic findings of Nagle (1967) on the differences between wave and current orientation. The unimodal orientation of the conical dacryoconarids unambiguously indicates current action, and this is supported by the strong orientation of the *Panenka*, even though it is of a shape which Nagle found to be relatively insensitive to currents.

The absolute palaeocurrent direction cannot be determined from the material available. Tapp (1970) recorded currents from due west at a number of Tanjilian localities, and this is consistent with recent, more accurate measurements from more distant localities of the Norton Gully Sandstone along the same structural trend as the study area (Powell *et al.* 1998).

Conclusions

The sediments at Dungaree Creek are of late Pragian or early Emsian age. The presence of coarse sandstone, and the orientation of the fossils, indicate turbidity currents; there is no evidence of wave action from the limited observations. Soft-sediment deformation under hard fossils, preservation of abundant plant remains, reworking and random orientation of shell breccia all indicate a period of rapid deposition.

Acknowledgements

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Addendum to 'Moss Collections from Lord Howe Island in the National Herbarium of Victoria (MEL)'

Josephine Milne[1] and Arthur W. Thies

Abstract
Plagiothecium howeanum Müll.Hal. *ex* Jaeger, *nomen nudum* is *Ectropothecium leucochlorum* (Hampe) Broth., the spelling of which is corrected. (*The Victorian Naturalist* **118** (3), 2001, 89-91.)

Hampe (1874) described a new species, *Drepano-hypnum leucochlorum*, from Lord Howe Island. This grammatically correct specific epithet ending is repeated in Hampe (1880), with the citation of *Hypnum* (Sect. *Drepano-Hypnum*) *leucochlorum*. According to the International Code of Botanical Nomenclature, this original spelling of the epithet must stand.

Mitten (1883) introduced the combination *Stereodon leucochlorum* (sic) (Hampe) Mitten. Paris (1904, p. 54) refers to the name *Hypnum leucochloron* (Hampe) Jaeger with *Drepano-Hypnum leucochloron* and *Stereodon leucochlorus* as synonyms. Brotherus (1908) transferred the species to *Ectropothecium*, as *E. leucochloron* (Hampe) Broth.

The name *Plagiothecium howeanum* was published without description as a *nomen nudum* by Jaeger (1878), attributed to Müll.Hal., citing 'Lord Howe's Island ad truncos (*Fullager* [sic])'. There is a collection identified as this species from Lord Howe Island collected by Fullagar (the correct spelling) at MEL (MEL 32391), and is likely to be the material referred to by Jaeger. Although there are no other collections in other Australian herbaria, duplicates may exist elsewhere. In any case, the specimen has no formal status as type since the name was not validly published. The collection (MEL 32391) also contains a label 'Platy-Hypnum Howeanum C. Müller', apparently in Hampe's hand (Thies (2000) incorrectly cited the label as 'Cyrto-Hypnum howeanum C.M.').

Thies (2000) suggested, on the basis of MEL 32391 that *P. howeanum* 'seems to be a good species'. However, further examination of the material has shown that MEL 32391 is actually *Ectropothecium leucochlorum* (Hampe) Broth., and agrees with several other collections of Fullagar's, correctly identified. The species was subsequently collected on Lord Howe Island by W.W. Watts in 1911 (c. 40 collections specimens in NSW) and more recently by D.H. Vitt, in 1981, (specimen in CANB; dupl. in ALTA).

Ectropothecium leucochlorum, which is endemic to Lord Howe Island, is a small, delicate moss with a creeping habit (Fig. 1a). It often has numerous side branches on which perigonia (male reproductive structures) usually occur. The stems and branches are c. 0.1 mm diameter and in cross-section the stem consists of outer stereid cells (small thick-walled cells), a core of wide cells, and lacks a central strand (Fig. 1b). Delicate filamentous or two cell wide hyaline (colourless) pseudoparaphyllia (minute filaments borne on the stem) occur at the base of branches (Fig. 1c-d). Leaves are non-decurrent (with leaf margins not extending down the stem below the point of insertion), generally spirally inserted and branch leaves are somewhat smaller than stem leaves. The leaves are narrowly obovate-acuminate (Fig. 1e), occasionally falcate (sickle-shaped leaf tip) (Fig. 1f), lack a nerve and the leaf margin is entire (Fig. 1e). Leaf cells are smooth, linear and thin-walled (Fig. 1g), and those at the basal corner of the leaf (alar cells) can vary from undifferentiated to greatly inflated (Fig. 1h). The sporophyte occurs on the main stem and the seta (c. 0.6-1.6 cm) is red, smooth and twisted to the left. The capsule lacks stomata and an annulus (specialized ring of cells around the rim of the capsule mouth). The peristome (teeth at capsule opening) is double and spores are 10-12 µm diameter.

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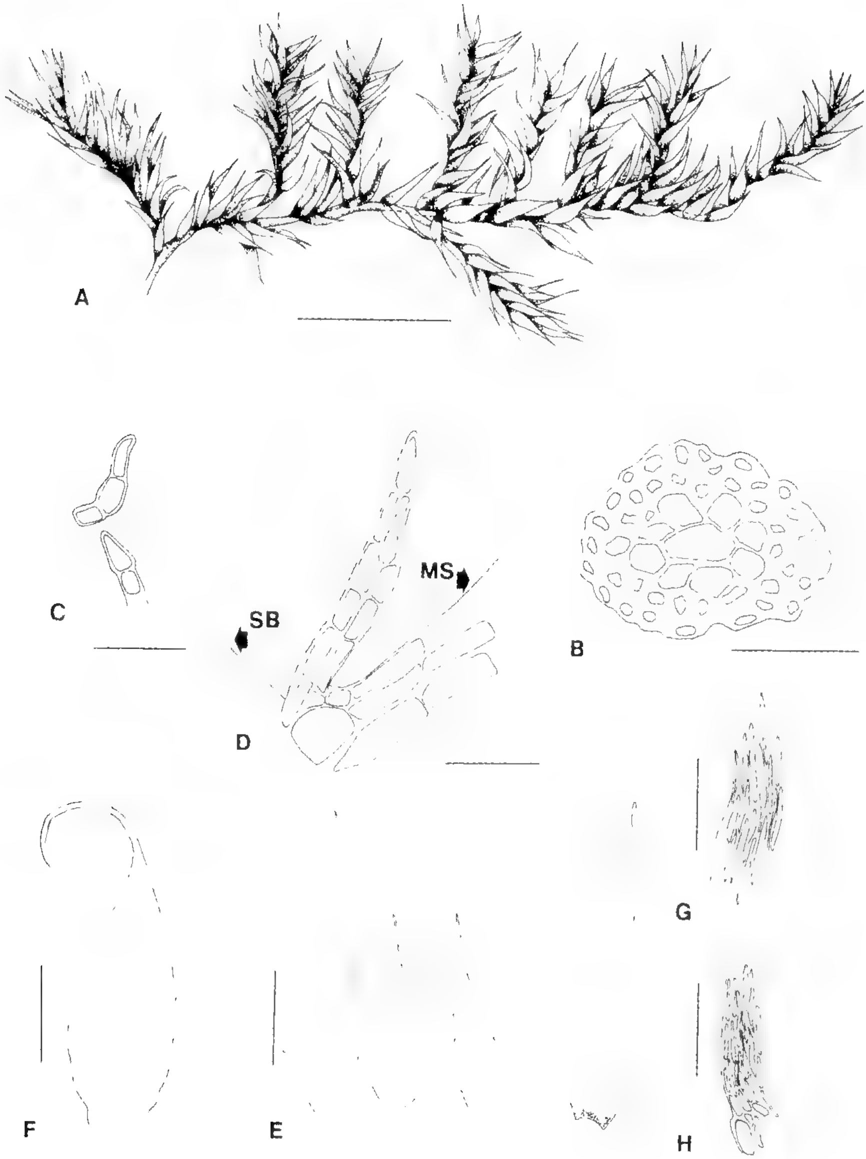

Fig. 1. MEL 32391. a) Plant habit; b) stem cross-section; c)-d) pseudoparaphyllia at origin of branches (MS = main stem, SBR = side branch); e) stem and branch leaves; f) falcate leaf; g) lamina cells at mid leaf; h) cells near stem insertion. Scale bars a) 2 mm, b)-d) 50 µm, e)-f) 300 µm, g)-h) 250 µm.

Acknowledgements

We thank an anonymous reviewer who pointed out the true affinity of the specimen labelled as *Plagiothecium howeanum* with *Ectropothecium*; Prof. R.D. Seppelt and Dr T. May for their valuable comments, Dr. A. Veenstra-Quah for assistance with the figures, the curator of NSW for the loan of herbarium specimens and staff at AD, BRI, CANB, HO and PERTH for checking holdings of herbarium specimens of this species.

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Flora and Fauna Guarantee Act 1988

The Flora and Fauna Guarantee Scientific Advisory Committee has made recommendations in relation to nominations for listing under the provisions of the ***Flora and Fauna Guarantee Act* 1988**. The following reports have been received:

Species/Process/Community		**Recommendation**
Final Recommendations		
Acacia phasmoides	Phantom Wattle	Supported
Acacia phlebophylla	Buffalo Sallow Wattle	Supported
Acianthus collinus	Inland Pixie Caps	Supported
Aprasia striolata	Striped Worm-lizard	Supported
Babingtonia crenulata	Fern-leaf Baeckea	Supported
Caladenia sp. aff. *venusta*	Kilsyth South Spider-orchid	Supported
Caladenia carnea var. *subulata*	Striped Pink Fingers	Supported
Caladenia colorata	Painted Spider-orchid	Supported
Caladenia cruciformis	Orchid spp.	Supported
Caladenia insularis	French Island Spider-orchid	Supported
Caladenia pilotensis	Mt Pilot Spider-orchid	Supported
Caladenia valida	Robust Spider-orchid	Supported
Caladenia versicolor	Candy Spider-orchid	Supported
Calomnion complanatum	Tree-fern Calomnion	Supported
Chthonicola sagittata	Speckled Warbler	Supported
Engaeus rostrogaleatus	Strzelecki Burrowing Cray	Supported
Egernia coventryi	Swamp Skink	Supported
Gaultheria hispida	Snow-berry	Supported
Litoria booroolongensis	Booroolong Frog	Supported
Litoria raniformis	Warty Bell Frog	Supported
Litoria verreauxii alpina	Alpine Tree Frog	Supported
Macronectes giganteus	Southern Giant-Petrel	Supported
Macronectes halli	Northern Giant-Petrel	Supported
Melanodryas cucullata	Hooded Robin	Supported
Megaptera novaeangliae	Humpback Whale	Supported
Neuropogon acromelanus	Lichen spp.	Supported
Nyctophilus timoriensis	Eastern Long-eared Bat	Supported
Oreoica gutturalis	Crested Bellbird	Supported
Peronomyrmex 'bartoni'	Ant sp.	Supported
Persoonia asperula	Mountain Geebung	Supported
Prasophyllum fosteri	Foster's Leek-orchid	Supported
Prasophyllum morganii	Cobungra Leek-orchid	Supported
Prasophyllum niphopedium	Marsh Leek-orchid	Supported
Pratia gelida	Snow Pratia	Supported

Species/Process/Community	**Recommendation**	
Final Recommendations (cont.)		
Pseudocephalozia paludicola	Liverwort	Supported
Pteropus poliocephalus	Grey-headed Flying-fox	Supported
Pterostylis aenigma	Enigmatic Greenhood	Supported
Pultenaea lapidosa	Mt Tambo Bush-pea	Supported
Spyridium nitidum	Shining Spyridium	Supported
Stagonopleura guttata	Diamond Firetail	Supported
Struthidea cinerea	Apostlebird	Supported
Thelymitra hiemalis	Winter Sun-orchid	Supported
Thelymitra gregaria	Balsalt Sun-orchid	Supported
Thunnus maccoyii	Southern Bluefin Tuna	Supported
Xanthoparmelia suberadicata	Foliose Lichen	Supported
Victorian temperate-woodland bird community	Listed as a community	Supported
The introduction and spread of the large earth bumblebee *Bombus terrestris* L. into Victorian terrestrial environments	Potentially Threatening Process	Supported
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Potentially Threatening Process	Supported
Preliminary Recommendations		
Euastacus neodiversus	South Gippsland Spiny Cray	Supported
Gramastacus insolitus	Western Swamp Cray	Supported
Hyridella glenelgensis	Glenelg Freshwater Mussel	Supported
Prasophyllum sp.	Swamp Leek-orchid	Supported

Copies of all reports are held in the FNCV library. Recommendation reports will be available on NRE's web page (http:/ www.nre.vic.gov.au).

A New Zealand Hepatic in Victoria

The leafy liverwort *Pedinophyllum monoicum* (Stephani) Grolle, until now thought to be a New Zealand endemic, has been found in cool temperate rainforest in the Yarra Ranges National Park, near Marysville. The specimen was collected from rotting wood and soil by Alex McLean of Monash University, while studying the bryophytes of Myrtle Beech *Nothofagus cunninghamii* forest. The identity was confirmed by David Glenny, Landcare Research New Zealand.

Although a member of the family Plagiochilaceae, *P. monoicum* is at first glance very similar to the common liverwort *Chiloscyphus semiteres* (formerly *Lophocolea semiteres*). However, *P. monoicum* has no underleaves, and there are copious rhizoids on the ventral surface on the lower parts of the stem. It is the only species in the genus that occurs in Australasia (Schuster 1963). It is described in Grolle (1960), Inoue and Schuster (1971) and Allison and Child (1975).

It is possible that this species will be found elsewhere in Victoria, and in Tasmania. For the present it must be considered to be endangered (ROTAP category 1E) in Australia, according to the criteria set out in Scott *et al.* (1997). Under the criteria currently used in Victoria it might also be classified as endangered in the State (D. Cameron, NRE Victoria, *pers. comm.*), but no formal assessment of its conservation status has been made.

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Effects of Grazing, Tourism and Climate Change on the Alpine Vegetation of Kosciuszko National Park

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Abstract
Activities in the past (grazing), present (tourism) and future (tourism and potential climate change) have documented or potential long-term impacts on the biologically significant alpine flora of Kosciuszko National Park, Australia. The management of these activities provides insights for the conservation of fragile ecosystems in the Australian Alps, and for other high use, high conservation-value reserves. Grazing caused widespread damage that has required expensive, ongoing revegetation, the costs of which have been borne by publicly funded conservation organisations. The increasing use of the area by summer tourists has also caused severe but more localised damage to the vegetation, that can largely be controlled and reduced by effective management of tracks, visitors and weeds. Management of the most recent threat, climate change, requires a holistic approach including lobbying for a reduction in greenhouse gas emissions. The predicted changes in climate may result in a sequence of changes in the distribution of the native alpine plant communities, including an increase in the diversity and abundance of alien plants. (*The Victorian Naturalist* **118** (3), 2001, 93-99.)

Introduction

The impact of human activities on vegetation communities has reached critical levels in many natural systems. These include alpine regions where human activities have resulted in long-term damage or irreversible change (Mosley 1989; Good and Grenier 1994; Bakker and Berendse 1999). This is, in part, the result of the limited capacity that some alpine environments have to recover from disturbance, due to the low energy of the system and resultant slow growth rates for vegetation (Costin *et al.* 2000; Jacobs 1992). Human-induced damage to alpine vegetation has jeopardised water quality in catchments, indigenous communities, sustainability of the harvesting of natural resources and mountain tourism (Cullen 1992; Williams and Costin 1994).

The largest contiguous alpine region (taken here to only include vegetation above 1830 m) in Australia is centred around Mt Kosciuszko in the south east of New South Wales (Fig. 1).

This area of 122 km² has been subjected to a range of harmful human activities despite the international biological significance of the area (Good 1992a). The unique qualities of Kosciuszko National Park led to its inclusion in the UNESCO Man and the Biosphere Program in 1977, as an International Biosphere Reserve (Good 1992a). The region was classified as an outstanding example of an alpine and subalpine environment, which contains unique communities, and areas of unusual natural features of exceptional interest. Human activities pose a threat to these qualities unless effectively managed.

Impacts of human activities

Grazing

Grazing was the first human activity to substantially alter the vegetation of the alpine region of Kosciuszko National Park (Table 1). Until the arrival of cattle and sheep, the flora had not experienced trampling by heavy, hard-hoofed animals (Good 1995). Grazing commenced in the 1830s and stock numbers were often high and ineffectively managed (Costin *et al.* 2000). The pressure of grazing was far beyond the capacity of the vegetation to sustain even seasonal usage (Good 1995). Decrease in vegetation cover, reductions in palatable species and changes in vegetation patterns and communities occurred (Helms 1893; Byles 1932; Costin 1954; Costin 1958; Costin *et al.* 1959; Costin *et al.* 1960; Bryant 1971; Good 1992a). The combination of regular intense grazing and the frequent use of fire as a management tool also led to severe sheet erosion, a legacy that remains with the park today (Bryant 1971; S.W. Johnston, *pers. comm.* 2000).

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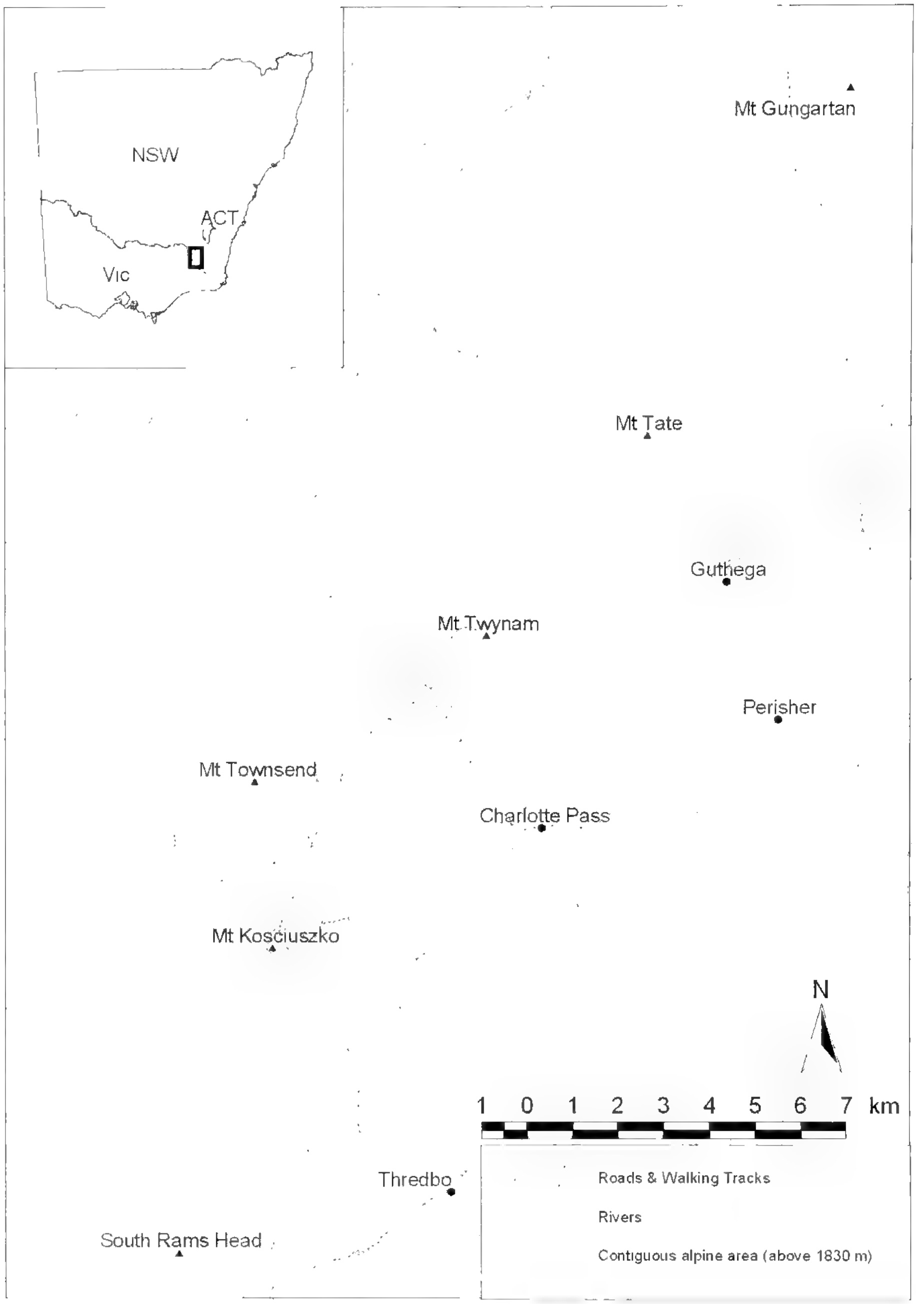

Fig. 1. Contiguous alpine area covered in this study around Mt Kosciuszko in Kosciuszko National Park, New South Wales, Australia.

The establishment of the Kosciusko State (later National) Park in 1944 and the start of the Snowy Mountains Hydroelectric Scheme in 1949 were the major factors that eventually led to the cessation of grazing in the Kosciuszko alpine area (Clark

1992; Good 1995). With the commencement of the hydroelectric scheme, the control of soil erosion and careful management of alpine catchments became crucial (Costin 1958; Costin and Polach 1971). Grazing leases were progressively withdrawn until in 1969, all grazing in what had become Kosciusko National Park was banned (Stanley 1982; NSW NPWS 1988). In 1957, a 25-year plan to revegetate and restore badly eroded areas commenced (Clothier and Condon 1968; Keane 1977; Clark 1992) and the most severely damaged lands were rehabilitated and revegetated. Although most of the revegetation works appeared to be successful at the time (sometimes after several treatments), there is now renewed erosion within these areas requiring more expensive rehabilitation (S.W. Johnston, *pers. comm.* 1999).

Grazing in the alpine zone highlights two general management issues. First, that damage to fragile ecosystems can have long term conservation and financial costs that greatly exceed the benefits of the original activity. Rehabilitation and stabilisation of the area cost in the order of A$4796 per hectare (A$2500 in 1984; Good 1995), considerably outweighing the benefit of the area as summer pasture (about A$10 to A$40 per hectare per annum, depending on method of estimation; values from Costin (1966) adjusted to 2000 values).

The second issue is that rehabilitation costs are often borne by organisations differing from those responsible for the original damage. In this case, rehabilitation was the responsibility of the publicly funded NSW Soil Conservation Service, and currently is the responsibility of the NSW National Parks and Wildlife Service. Therefore the benefits of grazing went primarily to private individuals, while the costs of repairing the damage resulting from the impacts of that activity was, and still is, borne by the public.

Tourism

With the end of grazing, tourism became the major issue for management in the alpine zone (Good 1992b; Buckley *et al.* 2000). As a result of increasing visitation, it is forecast that permanent and irreversible changes to the vegetation will occur (Table 1, Good 1995). Visitor numbers have increased with improved access to the area (Good 1995), increased public interest and environmental awareness (Mercer 1992) as well as efforts of the adjacent subalpine winter resorts to diversify and promote summer activities (Good 1995; König 1998). In the late 1970s, up to 1000 people per day visited the alpine zone (Edwards 1977). Currently over 2000 people per day visit the area during the peak holiday periods (S.W. Johnston, *pers. comm.* 1999).

The main tourist activities are walking, sightseeing and camping during summer and snowboarding and cross-country skiing in winter (Table 1). Impacts of tourism on the vegetation include trampling, introduction and spread of weeds, fire scars, littering, nutrient supplementation of soils and water, and the illegal collection of plants (Willard 1970; Liddle 1975; Cole 1985; Good and Grenier 1994; Good 1995; Zimmermann 1998; Buckley *et al.* 2000). To date, trampling and weeds appear to have had the greatest impact on the alpine vegetation (Edwards 1977; Mallen-Cooper 1990; Good 1992a).

The response by park management to erosion problems on tracks and trails has been the hardening of walkways with gravel, gravel within a plastic soil containment grid, raised wood or metal walkways, and pavers, along with controlled drainage lines (Good and Grenier 1994; CDT 1996). These management practices are expensive, with the rehabilitation of the summit area of Mt Kosciuszko and the surrounding area costing more than A$420,000 (NSW NPWS 1997). The most effective measure in terms of vegetation protection appears to be the construction of raised walkways. These reduce the physical contact of visitors with the flora, limit trampling and associated erosion and prevent the formation of multiple tracks particularly through bog and fen communities (Parr-Smith and Polley 1998). Raised walkways can also reduce weed establishment along track edges, because the introduction of gravel and sand is rarely necessary. Rehabilitation of track edges and other areas is an ongoing process using native seed and tube stock, mulch, fertiliser and plastic webbing (Terra Mat) at an overall cost of around A$119 per metre square (1997 values;

Table 1. Summary of human activities and effects on the vegetation of the alpine area of Kosciuszko National Park, Australia.

	Grazing	*Tourism*	*Climate change*
Timescale	100 years (ceased)[1]	1930s to present	30-70 years in future
Activities	Grazing[4] Burning Trampling Direct modification of drainage Deliberate and accidental establishment of introduced plants and animals	Walking on and off formal trails Sightseeing Camping Rock climbing Cross country skiing snowboarding Support and rescue vehicles	Direct: Alteration to temperature, precipitation and duration of snow cover[6] Increased length of exposure to high levels of UV light[7] Indirect: Alteration to competitive ability of different species of plants[8]
Problems	Vegetation loss[9] Soil exposure Soil erosion Spread of introduced plants	Changes in vegetation density and native species diversity[10] Trampling Collection of plant material Spread of weeds Increased nutrients	Potential threat to endemic species[8] Reduction in short alpine herbfield and snowbank feldmark communities Increase in weeds and feral animals
Trend	Increases in grazing numbers and damage, particularly in drought years[1]	Eight-fold increase since 1970s[11]	Mild to dramatic changes to climate and snow cover predicted[12]
Management Response	Initially ban on burning off and restrictions on grazing[1] Grazing banned outright in 1944 although not totally effective for at least a decade[1] Active revegetation program as part of soil conservation[13]	Hardened raised walkways and revegetation Minimum impact codes for bushwalking and camping Restriction on camping in sensitive areas Potential limit in tourism numbers[10]	Reduction in greenhouse gas production Control of weeds
Effect	Recovery of some communities and species Continuing problem of soil erosion and weeds	Reduction in damage per person, but still impacts Carrying capacity of walkways regularly exceeded	Limited unless effective reduction in greenhouse gas production

Costin 1954; Good 1992a. Clark 1992; Good 1992a. Whetton 1998. Costin 1954; Costin 1958; Mallen-Cooper 1990; Good 1992a. NSW NPWS 1988; Good 1992a; Mackay and Nixon 1995. Whetton 1998. Barnes *et al.* 1987; Teramura and Sullivan 1994; Good 1998; Kickert *et al.* 1999. Good 1998; Pickering 1998; Pickering and Armstrong 2000;[6] Costin 1954; Durham 1956; Taylor 1958b; Costin 1958; Costin *et al.* 1959; Costin *et al.* 1960; Wimbush and Costin 1979; Good 1992a; Costin *et al.* 2000. Durham 1956; Edwards 1977; Keane *et al.* 1979; Mallen-Cooper 1990; Good 1992a; Mackay and Nixon; 1995; S.W. Johnston *pers comm.* 2000; Johnston and Pickering; *unpubl. data.* Good 1992a; Mackay and Nixon 1995; S. Johnston *unpubl. data.* Whetton 1998. Taylor 1958a; Taylor 1958b; Clothier and Condon 1968; Costin and Polach 1971; Good 1992a. NSW NPWS 1988; NSW NPWS 1998; Parr-Smith and Polly 1998. AALC 1993a; AALC 1993b. Worboys 1997. WWF 1996; UN 1997; IPCC 1997. Buckley *et al.* 2000; Pickering and Armstrong 2000; Johnston and Pickering *unpubl. data.* [10] Johnston 1995; S.W. Johnston *pers. comm.* 1999.

Johnston 1997; Parr-Smith and Polley 1998).

Although there are no formal camp sites in the alpine zone, informal areas at popular sites often suffer from severe localised trampling, nutrient addition to soil and water from human waste, fire scars, root damage from digging and collection of firewood from the few woody species (AALC 1993a; Buckley *et al.* 2000). Open fires and camping in the catchments of the glacial lakes have been proscribed in an effort to limit tourism impacts (AALC 1993a, b). The provision of 'portaloos' within the alpine area in summer and the rotating composting toilets at Charlotte Pass are likely to reduce human waste in the alpine area, although they have their own impacts and are expensive management options (AALC 2000).

Due to their confined nature, tourism impacts appear to be much more controllable than those of grazing. In summer, people tend to stay on the designated tracks and trails and can, to a large extent, be effectively guided and directed by management tools such as informative signs, raised walkways, hardened tracks and the provision of toilets (NSW NPWS 1988). The major problem is increased usage. As park authorities work towards stabilising and hardening tracks and implementing other management strategies to direct people away from sensitive areas, problems will keep redeveloping as visitor numbers increase, expanding the areas of damage. The economic costs of these methods are high, although partly offset by revenue from the entrance fee to the park (currently A$15 and A$80 per car for a daily and annual pass respectively). As the limit to the effectiveness and desirability of the hardening strategy approaches, restrictions on numbers or even closure of some areas may well be required, particularly at peak times.

Climate change

Global warming is likely to be a major threat to the alpine environment with widespread effects on the ecology of the system (Green 1998; Pickering 1998; Pickering and Armstrong 2000). Predicted changes in temperature, precipitation and snow cover (Whetton 1998) are likely to alter the distribution of native and introduced plants and animals, the hydrology of the system and soil processes (Green 1998; Good 1998; Pickering 1998; Pickering and Armstrong 2000). The direct and indirect effects of these changes on the flora are difficult to predict but are likely to involve reductions in the distribution of certain plant species and communities, particularly the snowbank feldmark and short alpine herbfield communities that are associated with late snowbanks (Pickering 1998; Pickering and Armstrong 2000).

Climate change may be a greater threat to the alpine zone than either grazing or tourism. However, the impacts of grazing and tourism have been, or can be managed by altering human activities within the park; the same approach will not work for climate change. The threat from climate change is global in nature, with the issue being human activities at a truly global scale. Therefore part of the direct management response by park agencies should be the lobbying of organisations responsible for the production and/or control of greenhouse gases, including the Federal Government.

The clear legislative obligation of NSW National Parks and Wildlife Service and other conservation agencies to maintain the natural values of the environment may require them, more and more, to assume an advocate's role for the natural environment. This type of management approach, although vital for preserving conservation reserves, is likely to attract criticism from groups who see the responsibility of the parks services as limited to issues that can be managed within park boundaries.

There are two local programs that parks agencies can undertake to assist in dealing with the impacts of climate change indirectly. The first is a watching brief. The Australian Alps national parks including Kosciuszko National Park should join international monitoring programs such as GLORIA (Global Observation Research Initiative in Alpine Environments) that examine the impacts of climate change on natural systems. Monitoring would allow early detection of critical changes in the Australian alpine flora and fauna. Documenting changes in both the climate and the biota could highlight the impact of our activities on this fragile ecosystem, possibly adding support to moves to limit emissions.

The second program is the control of alien plants and animals. Although there are existing control programs, the problem is likely to amplify as climate change increases the abundance and diversity of weeds and feral animals in the alpine zone (Green 1998; Pickering 1998; Pickering and Armstrong 2000). It is also possible that tourism and climate change will have synergistic effects on the distribution of weeds in the alpine area further enhancing the problem (Buckley *et al.* 2000).

Conclusions

There have been, and continue to be, long-term negative effects of human activities on the Australian alpine vegetation despite expensive and committed management by conservation groups and other organisations. Grazing and associated activities have caused extensive damage to the vegetation and soil that still requires rehabilitation. Tourism, although with more localised effects, is causing damage, and has elicited expensive management responses that have their own environmental and aesthetic impacts on the region. Climate change is likely to have widespread, cascading ecological effects that are not amenable to a local management response. Currently the most effective method of limiting the impact of climate change would be to reduce greenhouse gas production, something that has been notable for its lack of success at a national level.

Acknowledgements

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Ant Behaviour Part 2

This note reports the apparently unusual and aggressive behaviour of a single Sugar Ant *Camponotus* sp. as observed at Ridge Park, Sugarloaf Reservoir, Christmas Hills, Victoria. The behaviour of this Sugar Ant contrasts with the report on Sugar Ants in the August 1999 issue of *The Victorian Naturalist* (Grey 1999) where they exhibited submissive behaviour in the presence of Meat Ants *Iridomyrmex purpureus*.

At 11 a.m. on 19 September 1999, a single Sugar Ant, subsequently identified as *Camponotus 'consobrinus'** (sub-family Formicinae) was observed at the entrance to the nest of a small, black ant, subsequently identified as *Anonychomyrma 'itinerans'* (sub-family Dolichoderinae). Identifications were made using keys from Andersen 1991, Greenslade 1979 and Shattuck 1999. The Sugar Ant repeatedly approached the nest entrance where it attacked (and was in turn attacked by) the small ants as they left, and returned to, the nest. This activity was observed for about 15 minutes and during this time one of the *A. 'itinerans'* was killed and another injured. Each bout, and there were quite a number, was short – a matter of seconds. The Sugar Ant used its mandibles to hold the small black ant while bending its abdomen (gaster) to bring the formic acid spray into action. This spray, directed through a conical opening (the acidopore) at the rear of the gaster, is used for defence and communication (Shattuck 1999). It was interesting to note the Sugar Ant ignored other species of ants, one a Ponerine species and the other a very small, brown ant (not identified), even though they were within the area where the attacks took place and close to the Sugar Ant.

In Andersen (1987), ants were grouped into seven ecological categories. *Anonychomyrma 'itinerans'* is a member of the dominant species group (Category 1). Category 1 ants are characterised as abundant, highly active and aggressive. On the other hand, the Sugar Ant *C. 'consobrinus'* belongs in Category 2 – subordinate species exhibiting submissive behaviour. Thus the aggressive behaviour of *C. 'consobrinus'* in this observation appears uncharacteristic.

* Inverted commas indicate a species group. A group is a complex of species closely allied to, and including, the named species (Andersen 1990).

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Vale
Ilma Dunn

We were deeply saddened to learn of the recent death of Ilma Dunn. Ilma was a long time member of the Field Naturalists Club of Victoria as well as an ardent supporter of the Fungimap scheme and a talented photographer. A tribute to Ilma will appear in a later issue.

A Guide to Squid, Cuttlefish and Octopuses of Australasia

Mark Norman and Amanda Reid

Publisher: *CSIRO Publishing and The Gould League of Australia, 2000. 96 pp. RRP $32.95.*

All beach-goers are familiar with 'cuttlebones' washed up on the strand, with occasional views of octopus in tidal pools and with calamari rings to finish off the day. But to most, knowledge goes little further as to the actual identity of these cephalopods or where and how they live, feed, and reproduce or their behaviour and relationship to other marine fauna.

The Australasian cephalopod fauna has been the subject of much research in recent years, as we have in our region perhaps as great a number of species of squids, cuttlefish and octopuses as anywhere in the world. Lu and Phillips (1985) catalogue over 220 nominal species but the more recent research, as outlined in *The Southern Synthesis* (Beasley *et al.* 1998), would put this number closer to 180 actual species (squid, 80; cuttlefish and allies, 50; octopus, 50). However there has been little in the way of field guides for their identification. *The Southern Synthesis* (Chaps 11-13) deals in detail with the anatomy, morphology and physiology of the Class Cephalopoda and the subclasses Nautiloidea (nautilus) and Coleoidea (cuttlefish, squids, octopuses). In the latter chapter keys to the various families are given (with line drawings of representative taxa) but lower taxonomic identifications are not made. In southern Australia we are a bit more fortunate in that Zeigler and Norris (1989) give keys and brief descriptions and some colour photos of our cephalopod fauna, and Edgar (1998) also has a small section on this fauna – but neither of these two books is complete nor easily used in the field.

Now, in this new publication by Norman and Reid, we have a very readable guide to the specific identity of at least some of the cephalopod fauna of the wider Australasian region. The fauna mentioned includes species from all parts of the Australian coastline with a number which occur only in the islands to our north. Some of the taxa have very extensive ranges, occurring throughout the western Pacific region, whilst others are quite restricted, e.g. The Capricorn octopus, known only from a single island group in the Great Barrier Reef. Introductory chapters deal very briefly with the evolution of cephalopods in geologic time, cephalopods today and the means of identifying the various groups of cephalopods. The largest section deals with sixty-three of the more common species of squids, cuttlefish and octopuses found in mainly shallower waters. Taxa described range from the huge Giant Squid (up to 2 metres mantle length and 18 metres overall) to species less than 2 cm overall length, and from those living in intertidal pools to the soft, gelatinous octopuses living at depths of several kilometers. One page is usually devoted to each species which is described with a half-page colour photo, a distribution map and a brief discussion of some of the more important points of the animal and something of the biology where known. A final section figures the most common beach-stranded sepions ('cuttlebones') although I feel that the rosy, bronze and bluish hues of these figures, which may be true of live-taken sepions, are quite strange for the normal white objects found on the beach. There is a short reading guide, a glossary and an index to complete the book. This book could be quite easily carried and used in the field but would almost certainly not stand immersion.

There is still a great deal to be found out about these animals – just two quotes from *The Southern Synthesis* – 'Life histories of the overwhelming majority of cephalopods are still unknown...' (p. 470) and '...the taxonomic importance of observing the colour patterns, skin textures and body postures of live animals' (p. 476). This is where the amateur beachgoer or diver can assist. Interesting, and previously unknown, behaviour of these animals can be gained if we take the opportunity of a chance encounter to simply observe e.g. Vafiadis (1998) on *Octopus maorum*. I feel a short section, with this in mind, on observing (photography, video-recording), collecting and preserving specimens would have been useful.

The photographers are to be congratulated as the photos used are quite exquisite (I liked the Striped Pyjama Squid) and, taking into account the colour changes that the Coeloidea are capable of with their chromatophore systems, should enable confident identification of the species dealt with.

I would recommend this book as a very useful guide for all marine-goers.

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Inverleigh, Victoria 3321.

Flora of Australia Volume 48
Ferns, Gymnosperms and Allied Groups

Publisher: *(ABRS)/CSIRO, 1998. 766 pp. 96 colour photographs, numerous black and white drawings, distribution maps.*
ISBN 0 643 05972 5 (soft cover). RRP $99.95
Available from CSIRO Publishing, PO Box 1139, Collingwood, Victoria 3066.

This wonderful volume of *Flora of Australia* caters for all those interested in our Australian non-flowering vascular plants. It is divided into two main sections, the ferns and fern allies and the gymnosperms. In each instance, a brief review of the taxonomic history of each group is provided giving the reader a quick, albeit rudimentary, understanding of previous taxonomic research. Similarly, the reader is given an overview of the morphology, biology and ecology of the two broad groups. This is ideal for those in the early stages of their studies although they must come to grips with terminology. To assist with this, a glossary of specialised and frequently used terms for the ferns, conifers and their allies is included at the back of the volume. It is not exhaustive but this is acknowledged and the reader is advised to use it in conjunction with the glossary in *Flora of Australia* Volume 1.

I have tested the key to the families of ferns and fern allies in Australia and found it simple and easy to use, making it ideal for the student and amateur and highly desired by the professional botanist! Each family has its own key to genera and each genus, similarly, has its own key to species. Although I have not tested all of these, they are designed in the same manner as the key to families and appear straightforward. Indeed, the ones I have tried posed no problems. Descriptions are brief and to the point, as they should be, photographs and drawings generally are of high quality, showing the intricate detail and quiet beauty of selected specimens. The proliferous buds in the distal axils of *Callipteris prolifera* (Figure 88 in the Volume) and the aerial shot of *Platycerium superbum* (Figure 150 in the Volume) are particularly captivating. Short notes on habitat and distribution are presented and information on type collections, chromosome numbers and published illustrations provided, supplemented by significant references and synonymy. This occurs for the gymnosperms as well.

No single key to the families of gymnosperms was provided, instead, each division has its own key to families, then families to genera etc. Several keys to families are provided for the Pinophyta: based on female specimens, male specimens and on vegetative characters. Again, photographs and drawings are of high quality and show the attention paid to detail by the photographers and artists. In both the gymnosperms and the fern and fern allies many of the photographs and diagrams are of reproductive structures, accentuating their importance as identification tools.

The chapters dealing with the fossil records of the ferns and fern allies and the gymnosperms are an important inclusion and help piece together the scattered information available, providing a holistic view of the changes that occurred over time with respect to these plant groups. The importance of continued comparative investigation of extant and fossil flora is highlighted by the mention that the discovery of Wollemi pine *Wollemia* supported the hypothesis that the Araucariaceae may have included an additional genus in the past, although, *Wollemia* has not been confirmed as a fossil. There still is much to be understood about the fossil record of our Australian non-flowering plants. Why, it is asked, did *Dacrycarpus* become extinct when apparently more susceptible genera survived? This is an important question as Australia is a large land mass and has, and presumably had, a wide variety of habitats. Why did *Cyathea* fail to recover from the last glacial when it has survived more extensive glaciation? Is there a factor restricting its expansion? If so, what?

The collation of the distribution maps for each species is particularly useful. In the first instance, it allows a rapid visualisation of the Australian biogeography of each species but, also, allows easy comparison between species. The instant recognition of isolated occurrences of many species highlights their vulnerability and the importance of their conservation/preservation.

An appendix presents new taxa, combinations, lectotypifications, epitypifications and neotypifications. There are quite a number of these accentuating the enormous amount of work done by the authors. One of the amazing points to note is that even large new species still are being described. Obviously there is a lot more work needed!

This volume of the *Flora of Australia* is comprehensive, authoritative, and written in easily understood English. The numerous black and white line drawings are an excellent aid to the text and, conveniently, are usually adjacent to the text or on the next page. The colour photographs were divided into three groups, which were dispersed throughout the volume, serving to break the monotony of black and white. While the photographs, therefore, were not near to the relevant text and some flipping of pages back and forth was necessary, it is understandable that this should occur, especially when considering convenience for putting the publication together and associated costs. There are a number of 'typos' scattered throughout the text, including incorrectly spelt words and omissions but this is a minor fault and the reader should not let this detract from the otherwise superb presentation of the volume. I highly recommend that anyone even remotely interested in Australia's ferns, fern allies and gymnosperms save their pennies, fill their piggy-banks and buy a copy of this volume of *Flora of Australia*!

Maria Gibson
School of Biological and Chemical Sciences,
Deakin University,
Clayton, Victoria 3168.

Compendium of FUNGIMAP Target Species
Version 1.0 [CD-ROM]

Publisher: *FUNGIMAP, Melbourne, Australia. RRP $15.00*

This outstanding first FUNGIMAP CD-ROM provides the user with detailed information on the 100 FUNGIMAP Target species in the form of written descriptions, numerous photos and illustrative material as well as the distribution maps created from the records sent in by volunteers across Australia. The CD also includes general information on FUNGIMAP, a glossary of mycological terms, and basic information on the structure of fungi. For those interested, further mycological information may be gained from the list of reference books and fungi web sites.

The opening screen makes it so easy to get started – just click on the topic *How to use this CD-ROM* and all is revealed. The icons are explained and navigation through the CD is clearly laid out. The opening statement was particularly reassuring: 'Explore the CD-ROM in any manner you like. You can't do it any harm and you can always return to the start by clicking this icon [HOME]'. *Troubleshooting* is also very helpful, especially with older machines and earlier versions of Windows where sometimes the whole screen is not visible, or 'the image is awful'. Answers are given with easily followed solutions. However, the CD-ROM needs a computer with a colour resolution of 800x600 (and higher) pixels, and is, unfortunately, only available for PC's not Mac's. The first screen is clearly set out with a list of topics on the right and on the left, a diagrammatic 'mushroom cap' divided into segments that when highlighted and clicked lead to the descriptions of the 100 FUNGIMAP Target species.

Everything that you need to know about participating in FUNGIMAP is included in the headings under *Fungimap*. In *Fungi Features* the stages of 'why a mushroom is mushroom-shaped' is amusing – first there is a sketch of a gill, a pore and a tooth, then clicking on the next 'principles' you get a collection of gills/pores/teeth, then 'a cover to keep off the rain' etc. This is especially useful for those of us who are new to the subject. Additional documents can also be accessed that include information for beginners, record sheets etc., and FUNGIMAP Newsletters 1-12.

In the next topic, *Fungi Skills*, microscopic images of some fungi spores have been included which further adds to the interest and study of the subject. The *Resources* topic shows the paucity of purely Australian fungi books, and indicates how necessary this CD-ROM is. Throughout the topics there are direct access routes to fungi web sites other than the FUNGIMAP site. This feature is very useful.

Back to the fun part of the opening screen – finding out about the 100 FUNGIMAP Target species. Access to each species can be done in a number of ways as indicated on the 'mushroom cap', which is divided into 8 segments and an inner circle. As the cursor moves over any of the sections, sample illustrations and text appears in boxes, which give more information about that segment. *All targets,* in the centre of the 'cap', takes you directly to the descriptions of the species starting at A – *Agaricus xanthodermus* Yellow Stainer as 1/100 down to 100/100 *Volvariella speciosa*.

From the outer segments of the 'cap', you can select whether you want to look at gilled fungi, those with pores or teeth, or any of the other types. All these, when activated, take the reader to a second screen with tagged files and thumbnail illustrations of each species. Clicking on any of the species illustrated will take you to its description. On the other hand, you can go to the Taxonomy segment that lists the species in their order, family, genus and species, and by clicking on any of the species here you can also go directly to the description. There is also another way to access the species, which I particularly liked – by colour. At the second screen the thumbnails are arranged in colour. I also found helpful those fungi listed by habitat, i.e. the *desert fungi*, and think it would also be useful if other species could be grouped according to habitat, or substrate.

The first screen of the description gives the name, etymology, taxonomy and common name, if there is one. Most of the screen is taken up with an illustration of the species, with arrows indicating the relevant macroscopic features that are characteristic of the fungus. This is an excellent feature and backed up with the more detailed description (accessed by the 'page' icon on the screen), and further photos (accessed by the 'camera' icon) enables a positive recognition of the species. The number of additional photos of the species is another commendable feature. They show the species in a variety of stages and aspects, thus giving the reader a 'concept' of the species, which is very important since fungi are so variable in many cases. The photos are excellent, and the wonderful thing is that FUNGIMAP volunteers have contributed all (over 700) free of charge. Unfortunately not all the species have further written descriptions, or a variety of other photos, thus making it difficult to identify these species, especially for beginners.

The map icon shows the distribution of the fungus. It is particularly gratifying that FUNGIMAP volunteers' records have very greatly increased the information on the distribution of most species. The red FUNGIMAP squares dominate almost every map (the blue ones indicate herbarium specimens, and the green, literary records). Victoria and Tasmania are seen to have a lot of records, but this is probably the distribution of recorders rather than a dearth of FUNGIMAP targets elsewhere.

Other information included with some species is a spore print, and any 'look alike' fungi. One feature I particularly liked was that when *Cyttaria gunnii* was said to grow on Myrtle Beech, by clicking on the camera icon near this information, an image of the Myrtle Beech was shown, similarly with *Banksiamyces macrocarpa* on *Banksia spinulosa*.

This is just the first version (see *How to use this CD-ROM – the 2nd edition*) and a later edition will fix up the lack of descriptions and photos as well as adding further features and an enlarged target species list. I shall look forward to that.

Ian Bell is to be congratulated on putting together such an elegant program – easy to use and tremendous fun. It will be especially useful for those just starting with FUNGIMAP; in fact, fungi in general, since there is information on many genera.

The RRP of $15.00 makes this CD-ROM an extremely good buy.

Pat Grey
8 Woona Court,
Yallambie,
Victoria 3085.

CD available from FUNGIMAP Royal Botanic Gardens Melbourne, Birdwood Avenue, South Yarra, Victoria 3141. Cost $15.00 + $3.00 (GST + postage and handling) anywhere in Australia. Cheques made out to: Field Naturalists Club of Victoria

100 Years Ago

WHERE THE BIRDS GO TO –

In a recent issue of the *Daily Mail* (London) some account was given of a sale of bird skins in that city. One firm sold no less than 2,151 female Birds of Paradise, while another had 847 and a third 531! These were sold in lots of 50 or 60 at from 16s. to 24s. per skin. One of the firms had 1,181 Impeyan Pheasants, together with large quantities of Osprey feathers, skins of parrots, jays, owls, crested pigeons, and other birds. A line of 1,000 lately deceased "Pretty Pollies" went off at $1^1/_4$ d. each!

From *The Victorian Naturalist* Vol. **XVIII**, 1901.

Stefanie Rennick
27 March 1918 – 3 January 2001

Environmentalist and Naturalist

Stefanie Rennick joined the Field Naturalists Club of Victoria 18 years ago, in 1983. About this time she also became a prominent environmentalist on the Mornington Peninsula. She joined the newly formed Southern Peninsula Tree Preservation Society and put to work her visions for the protection of biodiversity in the region. She was already a long time member of the Melbourne Women's Walking Club and also had an increasing interest in native plants. When there was a plan to subdivide part of Greens Bush she campaigned strongly for the whole area to be put into the Mornington Peninsula National Park. Finally, when this goal was realised, and when walking tracks were being constructed she had visions for a field guide for the whole Peninsula. A book committee was set up and a grant obtained. Stefanie worked tirelessly at this with assistance from Ilma Dunn, who supplied most of the photos. The book, 'The Mornington Peninsula: A field guide to the flora, fauna and walking tracks' (1990), was a great success, raising over $40,000 in book sales which she requested go to Trust for Nature to be used only for conservation on the Mornington Peninsula.

One campaign Stefanie fought strongly for was the relocation of the Main Ridge Equestrian Centre from Council-owned land adjacent to the Mornington Peninsula National Park. *Phytophthora* had been found in the area near a stream that runs into the Park, causing a serious threat to the flora of the Park. Stefanie fought Council bureaucracy for years in this ongoing saga and it is unfortunate she did not live to see the matter resolved. On a brighter note Stefanie had been engaged in a long-running dispute with the Shire over slashing roadside verges in late spring when many late flowering native species had not set seed. Because of her tenacious spirit, Council has changed its attitude and has identified many roadside verges for special protection.

Stefanie was also a member of the Southern Peninsula Indigenous Fauna and Flora Association and always had lots to say on local matters. At meetings she would nearly always bring along a bunch of environmental weeds to educate members, and spoke strongly for weed removal. All those she inspired are determined to keep fighting for the things she believed in and her vision for the

Peninsula. A granite tor with a bronze plaque has been erected in her honour on a section of the Two Bays Track. It reads

> In honour of
> Stefanie Rennick
> Teacher, Naturalist, Environmentalist
> and Bushwalker
> whose vision saw the establishment of
> The Two Bays Walking Track,
> and who has fought tirelessly for the
> Preservation of Mornington Peninsula's
> Biodiversity.
> A woman for all seasons.

Stefanie's environmental activities also extended to suburbia, where she used her teaching skills to introduce the students at Ormond East Primary School to indigenous plants. Together they built and looked after a native garden at Joyce's Park and thus she passed her knowledge and environmental ideas on to a new generation.

She was also involved and participated in activities with the Victorian National Parks Association, Native Corridor Research Group, and The Australian Plants Society (where she was made a life member). Somehow she also found time to contribute to *The Victorian Naturalist*!

Tom Sault
51 Russell Street,
Tootgarook, Victoria 3941.

Stefanie's photo supplied by her family

Lyle Courtney, OAM

Congratulations to Lyle Courtney, a long-time member of the Maryborough Field Naturalists Club, who was awarded the Medal of the Order of Australia in the General Division on Australia Day, 26 January 2001. Lyle's award was 'for service to the community through the collection and supply of Red-back Spider specimens for the production of antivenoms by the Commonwealth Serum Laboratories'.

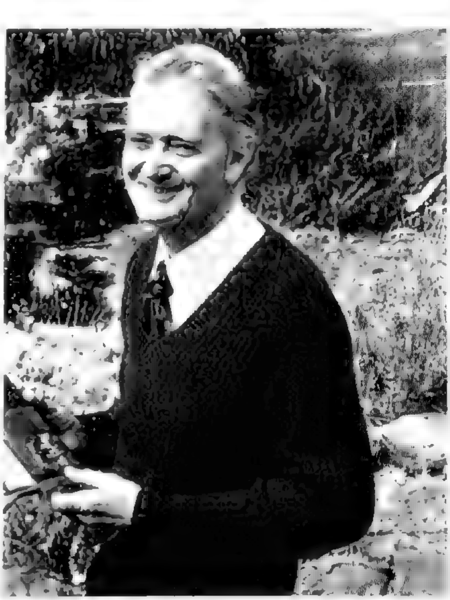
Inspired by an appeal from the late Crosbie Morrison, Lyle began collecting Red-backs in 1955 and over a period of more than 43 years supplied over 50,000 spiders to CSL. The vast majority of the spiders came from within a 50-mile radius of Maryborough, and, in true field naturalist style, Lyle has a record of every spider sent over the years to CSL.

The individual spiders required by CSL had to be large, so of course when Lyle was collecting he would see ten times more Red-backs than he captured and feels he can justifiably claim 'to have seen more Red-back Spiders than anyone else in the history of the human race'.

Lyle Courtney is probably more well-known to many members of the FNCV for his untiring conservation efforts in the last remaining remnants of his local Box-Ironbark forest.

Congratulations Lyle from all your FNCV colleagues.

The Editors



The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

OBJECTIVES: ***To stimulate interest in natural history and to preserve and protect Australian flora and fauna.***

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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Members receive *The Victorian Naturalist* and the monthly *Field Nat News* free. The Club organises several monthly meetings (free to all) and excursions (transport costs may be charged). Field work, including botany, mammal and invertebrate surveys, is being done at a number of locations in Victoria, and all members are encouraged to participate.

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The Victorian Naturalist

Volume 118 (4) **August 2001**

F.N.C.V.

Published by The Field Naturalists Club of Victoria *since 1884*

Vale Ilma Dunn
1911 – 2001
Photographer and Naturalist

Around 1960 Ilma joined the Native Plants Preservation Society and, in 1963, the Bird Observers Club. She joined the Field Naturalists Club of Victoria in 1972. From that time she was an active participant in the Club, especially the Botany Group, leading excursions and giving talks, including a memorable slide show of high country plants set to music. Ilma enjoyed attending Club and Botany Group meetings, and was a regular until prevented by frailty in recent years. She often brought along some interesting recent find for the table of exhibits, and also helped to prepare displays for open days. Her husband, David Dunn, also attended many Club activities, and was FNCV Treasurer from 1980 to 1984 (see *The Victorian Naturalist* 114: 259).

Already a keen photographer before joining the FNCV, her knowledge of natural history and skill in wildflower photography developed rapidly, her pictures being much admired for their artistic quality as well as their technical excellence. Ilma's favourite subjects were orchids and fungi, and she also photographed many wildflowers. She had a wide knowledge of plants and fungi, was interested in growing native and exotic orchids, and was also interested in the details of natural history, such as observing insect pollinators of orchids. Ilma sent in one of the very first batches of records to the Fungimap scheme in 1995, and continued to support the scheme by providing records and photos.

A number of Ilma's photographs appear in two recently published books. One is 'The Mornington Peninsula – a Field Guide to the Flora, Fauna and Walking Tracks' of which she was also a joint author with the late Stephanie Rennick. More recently, the book 'Wildflowers of Victoria', by Margaret Corrick and Bruce Fuhrer, contains further examples of her work.

Ilma and her husband David were enthusiastic supporters of the 'Photoflora' competitions and exhibitions organised by the Native Plants Preservation Society from 1963 to 1980. Ilma contributed both as a committee member, slide contributor and judge. She also played a major part in organising the subsequent 'Mini-Photoflora' series of audiovisuals which were made available to the public for borrowing and display.

Ilma was actively involved in the many projects of the Society to save and protect small areas of valuable native vegetation in danger of being lost to development. Through this activity she became a foundation member of the group whose work led to the setting aside of the Barak Willem Flora Reserve in South Belgrave with its wealth of botanical interest.

Ilma was very generous in allowing others to use her photos in talks and publications. Her photos appeared in the Viridans CD-ROM Wild Plants of Victoria, and are also represented in the NRE Flora Information System. A superb photo of the blue toadstool *Entoloma viresecens*, taken by Ilma in New Zealand, featured on the front cover of a recent issue of *The Victorian Naturalist*, Volume 118 (2). Her collection of more than 5 000 photographs is now housed at the Royal Botanic Gardens Melbourne. Ilma and David were close friends of Jim and Mavis Willis and Ilma also took some photographs for Jim on excursions in his later years.

In her last years, when no longer able to attend meetings or visit the bush, Ilma continued to enjoy her nature photography using the many fascinating plants, flowers and insects in her own garden. Serious ill-health in early 2001 curtailed her activity but she reached her 90th birthday in May, celebrating the occasion quietly with friends and relatives. She died peacefully in her sleep on the night of her birthday.

Ilma will be remembered fondly by her many friends in the FNCV for her gentle and inquisitive nature. She was always good company on excursions, and ever willing to share her knowledge of and enthusiasm for plants and fungi, and assist others with photographic techniques.

This tribute has been compiled
from information kindly supplied by
Geoff and Ruth Christensen, John Eichler,
Paul Gullan, Tom May and Hilary Weatherhead

The

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Cover: The Squirrel Glider *Petaurus norfolcensis* has been found to occasionally feed on vertebrates. Photo by John Seebeck. See article on page 123.

Our web page: http://calcite.apana.org.au/fncv/vicnat.html
email: fncv@vicnet.net.au

Long Distance Transport of Arsenic by Migrating Bogong Moths from Agricultural Lowlands to Mountain Ecosystems

Ken Green[1], Linda Broome[2], Dean Heinze[3] and Stuart Johnston[4]

Abstract

Bogong Moths *Agrotis infusa* (Lepidoptera: Noctuidae) migrate in spring from the inland plains of eastern Australia to aestivate up to 1000 km away in rock crevices in tors and periglacial blockstreams in the Snowy Mountains and Victorian Alps. In spring/summer 2000/01, heavy rains washed debris from caves in the Snowy Mountains, killing adjoining grass. Arsenic was detected in soils from the caves and soil and grass from outwash areas, but not in soils and grass from adjacent unaffected areas. Faeces from mammalian predators of moths contained more arsenic than faeces from a herbivore from the same region. Arsenic levels were higher in moths from caves in the Snowy Mountains where vegetation was killed than in moths from the ACT or Victoria. The results indicate long distance transport of sublethal quantities of arsenic which are then concentrated to damaging levels by the millions of moths at aestivation sites. (*The Victorian Naturalist* **118** (4), 2001, 112-116.)

Introduction

The larvae of Bogong Moths *Agrotis infusa* (Noctuidae) are found from autumn to spring in eastern Australia from the Darling Downs in Queensland, south to the north-western plains of Victoria (Fig. 1). These areas have historically been used for grazing and cropping, and the Bogong Moth cutworm larvae are sometimes considered an agricultural pest (Common 1954). The larvae feed on annuals, but in the absence of their food plants over summer the moths migrate to the Australian Alps where they fast while aestivating gregariously in rock crevices and caves (Common 1954). Historically, Bogong Moths formed an important part of the summer diet of Aboriginal people from around the Australian Alps (Flood 1980). Today they still form an important part of the diets of many vertebrate species, including the endangered Mountain Pygmy-possum *Burramys parvus*, the most reliant of the native mammals on Bogong Moths (Mansergh and Broome 1994).

Heavy rains in November 2000 washed accumulated debris of dead moths out of many aestivation sites. In January 2001 complete mortality of grass *Poa fawcettiae* in the outwash zone at one site prompted an investigation of possible chemical contamination in the moths, the affected soils and vegetation.

[1] National Parks and Wildlife Service, Snowy Mountains Region, PO Box 2228, Jindabyne, NSW 2627.

[2] National Parks and Wildlife Service, Threatened Species Unit, PO Box 2115, Queanbeyan, NSW 2620.

[3] La Trobe University, PO Box 821, Wodonga, Victoria 3689

[4] Johnston Environmental Consulting Pty Ltd, 5 Nightingale Lane, Berridale, NSW 2628.

Methods

In order to examine soil chemical properties in detail, soil samples were collected (approximately 0-10 cm depth) from up to five separate areas within each site and samples were then pooled. Samples were collected from within caves used as aestivation sites by Bogong Moths, in the area outside the cave over which water and debris from the cave had drained, and as close as possible to this but outside of the drainage line from the cave. Soil exchangeable cations were determined using an ammonium acetate extraction (Lambert 1978) and analysed on a Varian Flame Atomic Absorption Spectrophotometer. Statistical analysis of arsenic levels was undertaken using two-way ANOVA.

From preliminary findings it was established that arsenic occurred in higher concentration in affected soils, and therefore, subsequent analysis concentrated on this one element.

Bogong Moths were collected live by hand at aestivation sites or by ultra violet moth lights at Mt. Gingera (ACT), South Ramshead (Snowy Mountains NSW) and from Mt. Buller and Mt. Buffalo (Victoria) (Fig. 1). Sample size varied from 50-120 moths depending upon availability, and

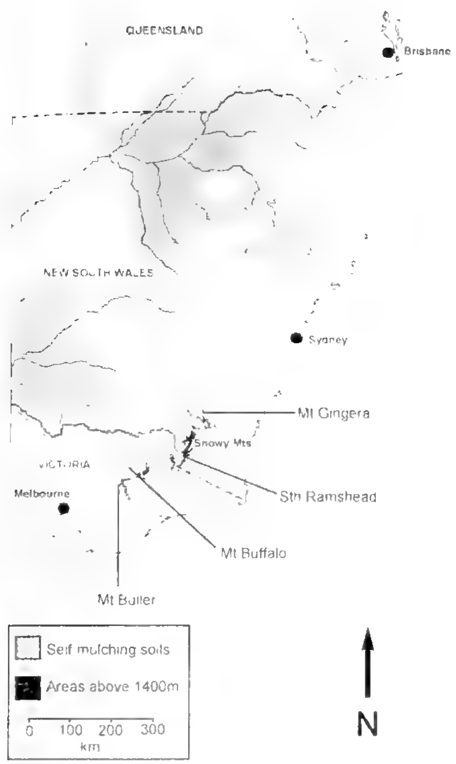

Fig. 1. Map of south eastern Australia showing areas above 1400 m altitude, including the mountain aestivation sites sampled in the present study, and the chief areas of self-mulching soils that appear to be the most important breeding grounds of Bogong Moths (after Common 1954).

samples were pooled and frozen as soon as possible after capture. Analysis was of a subsample of approximately 50 moths (adjusted to give approximately equal mass) from each location. Analysis of arsenic levels in Bogong Moths was conducted using a nitric acid digest (modified from Rayment and Higginson 1992) with arsenic determination on a Varian Vista ICP-MS (Inductively Coupled Plasma - Mass Spectrophotometer).

Samples of grass were collected from three to four sites of approximately 400 cm^2 within the area outside the cave over which water from the cave drained (dead grass) and from adjacent to this, outside of the cave drainage but still close to the

Table 1. Elemental arsenic content of Bogong Moths *Agrotis infusa* compared to a known sample of 0.0000 $\mu g.kg^{-1}$ arsenic (for use with samples at low concentrations).

Location	Elemental arsenic ($\mu g.kg^{-1}$)
Control (known sample)	0.103
Mt. Gingera (ACT)	0.101
South Ramshead (NSW)	2.296
Mt. Buffalo (Vic)	0.186
Mt. Buller (Vic)	0.333

rocks (live grass). Grass samples were pooled, sub-sampled and then prepared using a wet acid digestion method using hydrochloric acid (Lambert 1978, Rayment and Higginson 1992) and analysed on a Varian Flame Atomic Absorption Spectrophotometer.

Sub-sampling of stored faeces of Mountain Pygmy-possums was conducted following the discovery of arsenic in the mountain system. Faecal samples had been collected annually for dietary studies and stored frozen. Individual samples were sub-sampled so as to retain information on diet, and all samples for one area were then pooled. Three other mammal species were also tested. These were trapped at Smiggin Holes, 3.5 km from the nearest Bogong Moth aestivation site. These had differing diets ranging from insectivorous (Dusky Antechinus *Antechinus swainsonii*), omnivorous with the major food being fungus and insects (Bush Rat *Rattus fuscipes*) and one obligate herbivore (Tooarana or Broad-toothed Rat *Mastacomys fuscus*) (Green and Osborne 1994). Samples from the latter species were chosen as representative of background levels of arsenic in mountain mammals. Only *M. fuscus* is marked individually on the trapping grid, so samples could be collected from individuals over the three days of trapping. For the other two species which were not marked individually, faeces were pooled from all animals after the first night's trapping. Analysis of arsenic levels in faecal samples was undertaken using ICP-MS (Inductively Coupled Plasma - Mass Spectrometry) on a Hewlett Packard HP4500 ICP-MS using nitric acid digest (Rayment and Higginson 1992).

Table 2 Arsenic levels in soils adjacent to moth aestivation sites where live moths were sampled and for all sites combined. (Each site is pooled from up to five samples.) Mean and standard deviation.

Site		Grass state	Elemental arsenic (mg.kg⁻¹)
South Ramshead site 2	in cave	n/a	15.7272
South Ramshead site 2	outwash area	Dead	3.5551
South Ramshead site 2	undisturbed	Live	0.0000
Average of 8 sites	in cave	n/a	6.0292±8.9292
Average of 8 sites	outwash area	Dead	0.5035±1.2553
Average of 8 sites	undisturbed	Live	0.0005±0.0013
Mt. Gingera	in cave	n/a	0.1542
Mt. Gingera	outwash area	Live	0.0000
Mt. Gingera	undisturbed	Live	0.0000

Results and Discussion

The movements of arsenic from Bogong Moths to soil to grass and from moths to mammals are firmly established (Tables 1-4). There was a significant trend ($F=3.593$, $P<0.05$) of decreasing levels of arsenic in soils from caves to unaffected sites outside of drainage lines (Table 2) that mirrored the observed effect on vegetation. The analyses of unaffected soils, live grass and herbivore faeces indicated that the arsenic in the affected soil, dead grass and faeces of insectivores was not of local origin but had been introduced to the system by immigrant insects. The presence of arsenic in the most heavily preyed upon insect, the Bogong Moth (Table 1), indicates that these moths are the source of arsenic at the aestivation sites. Bogong Moths do not feed locally during aestivation (Common 1954) so it is most likely that the arsenic originated in the soils where the larvae feed (I.F.B. Common, *pers. comm.*). The distances between the larval sites inland to the aestivation sites in the mountains is up to 1000 km. This finding constitutes yet another example of long-distance transport of pollutants, but one that is unusual in that an insect is the transporting agent. Although there are few data on insects, the levels of arsenic detected in moths at the most affected site were well below levels causing mortality of moths elsewhere (Fisler 1994). Arsenic levels in moths were highest at the location where the impact of outwash from aestivation sites on vegetation was first noted at South Ramshead. Arsenic levels in caves and outwash (Table 2) reflect the differing levels found in the moths at Mount Gingera and South Ramshead (Table 1). Soils at five other sites where grass was killed had similarly elevated levels of arsenic in the cave and outwash relative to undisturbed soil. Unfortunately the phenomenon was noticed too late in the season to sample moths at those sites prior to their emigration. The compound containing the arsenic has not yet been identified, due to the shortage of moths subsequent to the main migration, but all dead grass contained levels of arsenic not found in live grass (Table 3). There was obviously uptake of arsenic from the soil by the grass although the causal connection of arsenic with grass mortality is not firmly established. The arsenic levels in soils in two caves at South Ramshead, a major aestivation site south-west of Mt. Kosciuszko, were higher, at 15.7 and 23.8 ppm, than residues generally found in farmlands in America (Yan-Chu 1994) and orchards in New South Wales (EPA 1995) but within the range of residues accumulated in orchards in America (Yan-Chu 1994).

Table 3. Elemental arsenic content in affected and unaffected grass beside moth aestivation sites at South Ramshead. (Each site is pooled from up to four samples.)

Site	Grass state	Elemental arsenic (mg.kg⁻¹)
Site 1		
edge of cave	Dead	0.005
outwash area	Dead	0.006
Site 5		
undisturbed	Live	0.000
outwash area	Dead	0.006
Site 6		
outwash area	Dead	0.007

Arsenic appears to be well entrenched in the mammalian insectivore food chain,

Table 4. Elemental arsenic content (mg.kg⁻¹) of faeces of three mammal species that feed on Bogong Moths and one herbivore (*Mastacomys fuscus*) acting as a control.

Year	1994	1995	1998	2000
Burramys parvus				
Trap grid 1	0.1	0.4	0.1	<0.2
Trap grid 2	<0.5	1.6	<0.2	<0.2
Trap grid 3				<0.5
Trap grid 4	0.2	<0.1	0.3	0.3
Trap grid 5	<0.5	0.8*	0.1	<0.5
Trap grid 6	0.2	0.4	<0.5	0.3
Smiggin Holes:				
Antechinus swainsonii				0.5
Rattus fuscipes				0.6
Mastacomys fuscus				<0.1

*1994 and 1995 combined.

with only one species of small mammal tested, the herbivorous Tooarana or Broad-toothed Rat, being unaffected. The impacts of arsenic within the mountain ecosystem are unknown. The small size and the rarity of dead specimens of the endangered Mountain Pygmy-possum make it difficult to collect samples to determine the levels in tissue and to speculate as to its possible effect in suppressing the population of Mountain Pygmy-possums.

Bioaccumulation of environmental pollutants and their concentration by terrestrial organisms normally occur *in situ* in, for example, plants such as willows (*Salix* spp.) (Larison *et al.* 2000). Exceptions to this are where transport of pollutants occurs through the action of wind or water prior to uptake (Sivertsen *et al.* 1995; Kalas *et al.* 2000) with levels generally decreasing with distance from the source (Kalas *et al.* 2000). What is less frequently documented is the long-distance transport of small amounts of chemicals by individual organisms and subsequent concentration to detrimental levels. The altitudinal flow of anthropogenic nutrients such as crop fertilisers has, however, been documented for phosphorus in windblown Alfalfa Moths *Loxostage cerareolis* (Halfpenny 1994).

Polluting sources such as smelters and fossil fuel power plants are major sources of arsenic in surface soils (Yan-Chu 1994). However, Bogong Moths come from upwind of the eastern seaboard of Australia where industry is concentrated. It is possible that there are natural sources of arsenic in systems from which the larvae feed which are amplified by bioaccumulation via the Bogong Moths. However, a more likely source is agricultural. The use of arsenic in agriculture has left a legacy of broad-acre contamination of soils, mainly associated with areas of intensive agriculture and horticulture (EPA 2001). Arsenic has been used in a variety of agricultural applications: in pesticides, insecticides and in cattle and sheep dips (Azcue and Nriagu 1994). It has also been used as lead arsenate for the control of moths in fruit crops (Buchanan 1977; Yoon and Kim 1977). From the 1860s to 1940s, when DDT was introduced, arsenical compounds were the major insecticides available to agriculture (Nriagu and Azcue 1990) and remained in use in Australia until the 1950s and 1960s (EPA 2001). The major use of arsenic is still in agriculture in various forms including monosodium methylarsonate (MSMA) (Azcue and Nriagu 1994). There are five MSMA herbicide sprays currently licensed for use in agriculture in New South Wales (National Registration Authority 2001). In soils, arsenic is present as arsenate (AsO_4^{3-}), and its behaviour resembles that of phosphate (Davies and Jones 1988). For example, arsenate is absorbed by ligand exchange on hydrous iron and aluminium oxides (Davies and Jones 1988). This study shows that the soils of the Snowy Mountains have naturally low levels of exchangeable arsenic. Addition to these soils of exogenous arsenic, which is readily taken up by plants, has led to major impacts on the vegetation around the aestivation areas.

The presence of arsenic in all four years for which faeces of *B. parvus* were tested (Table 4) suggests that arsenic may be transported to the mountains annually. This suggests that there may be regular absorption of arsenic by the cutworm larvae, probably from their food plants. Small amounts of arsenic are then transported at low concentrations, by individual moths but in extremely high numbers, and concentrated where they congregate in the mountains, causing visible and extensive damage. The arsenic content of moths and soils at Mt. Gingera (Tables 1 and 2), contrasting to those at South Ramshead and in Victoria, suggests that there are different sources of these moths. It has long been suspected that Bogong Moths in different aestivation sites come from different areas and this study adds credence to that speculation. This question may be resolved by genetic studies matching adults to larvae from known agricultural areas. Collection of material for this study is currently in progress with the primary aim of the genetic study being to narrow the focus of searching for the source of the arsenic.

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International Year of Mountains 2002

The United Nations has declared 2002 as the International Year of Mountains. The aim is to celebrate and focus global attention on mountain communities and environments. A number of activities associated with mountain environments in Australia are already planned including a 'biodiversity blitz' at Kosciuszko in January (under the auspices of the Australian Institute of Alpine Studies) and a conference on rehabilitation of mountain ecosystems in November (Australian Alps Liaison Committee).

A Review of Insect-induced Galls and Mistletoes on Buloke *Allocasuarina luehmannii* in the Victorian Wimmera

Matthew F. Wright[1] and Diana R. Burgess[2,3]

Abstract

Remnants of Buloke *Allocasuarina luehmannii* on the Wimmera plains of Victoria are host to gall-inducing insects and mistletoes. The taxonomy, life cycle and morphological variability of the *Cylindrococcus* gall-formers are reviewed, together with their potential for damage and methods of control. The host range and population status of two buloke-associated mistletoe species, *Amyema linophyllum* and *Lysiana exocarpi*, are described and their effects on the buloke host are considered. The review revealed a lack of information about environmental factors that may cause gall and mistletoe populations to increase at the expense of their buloke hosts. (*The Victorian Naturalist* **118** (4), 2001, 117-122.)

Introduction

Buloke *Allocasuarina luehmannii* R.T. Baker (Casuarinaceae) is the dominant or co-dominant tree species in remnant woodlands on the Wimmera plains of Victoria (Lunt *et al.* 1998). These ecosystems were once extensive on the better-drained, fertile soils of the Wimmera (Goucher 1982; Morcom and Westbrooke 1998) and played a vital role in the ecology of indigenous flora and fauna (Connor 1996; Emison 1996; Morison and Harvey 1997). After extensive clearing, 95% (16,700 km^2) of this land is now under cultivation (Land Conservation Council 1985), leaving a mosaic of isolated remnants on roadsides and freehold land.

Buloke is listed as depleted under the Flora and Fauna Guarantee Act (Morison and Harvey 1997). Its failure to regenerate, especially in northern areas (Flux 1998), and the death of mature trees (W. Jones *pers. comm.*; D. Burgess *unpubl. data*) is cause for concern. Decline and death of native trees in isolated remnants has been attributed to increased infestation by mistletoes and insects (Loyn 1987; Wylie *et al.* 1993) resulting from vegetation removal (Thomas 1997). This review will discuss the gall and mistletoe parasites of Buloke, and will consider their implications for the survival and conservation of Buloke in the Victorian Wimmera.

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Insect-induced galls

Insect-induced galls are atypical growths produced in response to insect feeding on a host plant (Mani 1992; Austin and Dangerfield 1998). Growth forms range from almost normal plant organs to bizarre and complex abnormalities (Mani 1992). Gall shape and morphology is often unique to the inducing insect species (Rohfritsch 1992), facilitating its identification (Manners 1993). Most gall-inducers are host specific (Dreger-Jauffret and Shorthouse 1992), the result of a prolonged evolutionary association (Roskam 1992). Galls are physiological sinks, drawing photoassimilates from the plant into specialised nutritive cells that supply the gall insect (Rohfritsch 1992; Ananthakrishnan 1998).

Recorded gall-inducers of *Casuarina* and *Allocasuarina* species are few compared to some other major Australian plant genera. They include three closely related species of Thysanoptera, which produce bulbous woody galls on tree stems (Jones and Elliot 1995; New 1997), species of Hymenoptera which form cone-like bud galls on *Casuarina quadrivalvis* (French 1911), and *Skusemyia allocasuarinae* (Diptera), which damages lateral branch buds of *Allocasuarina verticillata* (Kolesik 1995). The coccid *Cylindrococcus* spp. form galls similar in appearance to *Allocasuarina* fruit on host stems (Gullan 1984; Jones and Elliot 1995).

Cylindrococcus casuarinae Maskell is the only gall-inducer recorded on Buloke, and is in fact specific to *Casuarina* and

Allocasuarina (Gullan 1978, 1984). *Cylindrococcus* spp. are by far the most intensively studied gall-formers on Casuarinaceae. Initially *Cylindrococcus* was raised to include *C. casuarinae* and *C. spiniferus* (Maskell 1892), then two further species, *C. amplior* (Maskell 1893) and *C. gracilis* (Fuller 1897), were reported from *Casuarina* in Australia. However, Gullan's study (1984) of the gall type and adult female morphology of these four species revealed insufficient features to support this separation. She therefore reclassified them into two 'species-pairs', *C. amplior* being synonymised with *C. casuarinae*, and *C. gracilis* with *C. spiniferus*.

The lifecycle of *C. casuarinae* is typical of the coccids. The female, a sessile, plump, pinkish insect, about 0.4 cm long when fully grown, occupies the central gall cavity throughout her life (Jones and Elliot 1995). Small, six legged larvae move out through an opening in the gall, migrate along the stem, and form feeding attachments (McKeown 1942). The introduction of insect saliva into the stem stimulates host cell growth, causing the stem to expand and surround the larva (McKeown 1942; McMaugh 1994). The male, in contrast to the large degenerate female, undergoes complete metamorphosis into a small, gall-independent insect, with a single pair of wings, non-functional mouthparts and long external genitalia (Gullan 1978). It escapes through an opening in the gall (McKeown 1942), then fertilises a female by penetrating between the bracts of the female gall with its long external genitalia (Gullan 1978).

Male and female galls are generally found on the same stem (Gullan 1984) and are often densely aggregated, reflecting the limited dispersal of the independent larvae. The mature female gall of *C. casuarinae* closely mimics the fruiting capsules of *Allocasuarina* species (Jones and Elliot 1995), the galls being conical to fusiform, 10-32 mm long, widest (2-15 mm) towards the base, and with a stalk 1-5 mm long. The gall body is grey, glabrous or pilose, with brownish apex and basal bracts. The body consists of 4-6 thickened bracts that taper to the pointed apex, and the base is surrounded by 6-15 whorls of leaf-like bracts that become smaller towards the stalk (Gullan 1984). The male gall is similar in structure to that of the female, but is distinguished by its slender shape (maximum length 17 mm, maximum width 2.5 mm) and extremely attenuate bracts (Gullan 1978).

Gullan (1984) found that mature galls of *C. casuarinae* range in shape from broad to slender, with the two extremes being most common. The broad gall, with a maximum diameter of 4-15 mm, is of the form *C. amplior* and the slender gall, maximum diameter 2-7 mm (usually <5 mm) is of the form *C. casuarinae*. Although galls broaden with maturity, this does not account for the observed morphological variability. Nor does host plant response cause gall variability, because galls of both types were collected from a single specimen of Sheoak, *Allocasuarina verticillata* (Gullan 1984).

Cylindrococcus casuarinae is widely distributed (although infrequent) in south-eastern Australia and in the south-west of Western Australia. Gullan (1984) ruled out geographic variation as the cause of size variability, even though galls from coastal localities were often thinner than those collected inland. Galls growing on Buloke in New South Wales were of the broad form only; for example, collections from Burrewarra Point contained only broad galls, while both slender and broad galls were collected from Sheoak. This suggests that the potential for infestation of Buloke by the slender gall was present, but was either not expressed or not recorded. Gullan (1984) suggested that variation in gall form results from the dioecious nature of *Allocasuarina* spp., galls growing on male and female plants differing in size. This hypothesis has not been thoroughly tested, but Wright (*unpubl. data*) observed both slender and broad galls on Buloke in the eastern Wimmera of Victoria, an area not sampled by Gullan. Furthermore, slender galls were found on both sexes of Buloke, providing evidence to reject Gullan's hypothesis. Since Gullan's collections were primarily from Sheoak, conclusions regarding the associations between *C. casuarinae* and Buloke must still be tentative. Further research, based on a larger host sample and geographic distribution, is needed to understand this morphological variation.

There is little information about the effects of *Cylindrococcus* spp. on the host plant. Gullan (1978) noted that galls of *C. spiniferus* arose from the growing tips of branchlets. In the absence of compensatory growth, termination of tip growth would reduce the photosynthetic capacity of the plant. Deleterious effects on growth and reproduction might also result from the physiological sink effect of galling, especially under conditions of stress. This topic is largely unresearched, but is important, especially in view of the decline and depletion of Buloke noted earlier.

Control of *Cylindrococcus* spp. has received little attention, as Buloke is not an agricultural or economic species. Jones and Elliot (1995) suggested that in an undisturbed environment *Cylindrococcus* galls are controlled by parasitic wasps. Artificial methods of control, including chemical control and removal of galls by hand (Jones and Elliot 1995; McMaugh 1994), have been largely unsuccessful. Fire is known to eliminate some phytophagous insects (Gill 1996), but the impact of burning on the host trees and ecosystem may make this method of control unadvisable. Applications of fertiliser can reduce insect attack (Hadlington and Johnston 1998), but the effectiveness against *Cylindrococcus* has not been assessed.

In addition to the gall-formers, plant galls support whole communities of insects, including natural enemies. A study by Austin and Dangerfield (1998) on gall wasps of *Banksia marginata* revealed that 57% of sampled galls were occupied by other insects, including 11 species of Hymenoptera, three of Coleoptera and one of Lepidoptera. The relationships between these secondary colonisers are poorly understood and there are no descriptions of the insect communities in *Cylindrococcus* galls. This highlights the limited knowledge of the ecology of *Cylindrococcus* galls and the need for further research, especially before undertaking gall control, as chemicals that remove natural control agents within the gall may exacerbate rather than reduce galling.

Mistletoe parasites

Mistletoes are highly specialised and geographically widespread hemi-parasitic plants. Australia has 86 species of native mistletoe, distributed in forests, woodlands and shrubland communities throughout the continent (Reid 1997).

The response of a host plant to mistletoe parasitism varies from spectacular growth abnormalities to almost no visible symptoms (Calder 1997). Mistletoes compete for water, inorganic ions and metabolites (Ehleringer *et al.* 1985; Downey *et al.* 1997), causing reduction or inhibition of host growth (Nicholson 1955; Reid *et al.* 1994) and defoliation and replacement of host foliage with mistletoe (Kenneally 1973). Mistletoe infection may also produce imbalances in growth regulation by the host, and introduce toxins through the haustorial interface (Stewart and Press 1990; Downey *et al.* 1997).

Damaging levels of mistletoe infestation both in agricultural environments and in forests in Victoria have been recorded since the early 1900s (Patton 1917; Kerr 1925; Calder 1997; Fagg 1997). Nevertheless, host death was uncommon, and was generally attributed to drought, salinity, senescence or rural dieback (Hart 1961). The interaction between mistletoe damage and these factors has not yet been assessed.

Of the 12 mistletoe species native to Victoria only two are recorded on Buloke (Calder 1997). *Amyema linophyllum* or Buloke Mistletoe is found only on *Allocasuarina* and *Casuarina* spp. (Lunt *et al.* 1998). This species shows striking mimicry, its leaves being so similar to the Buloke branchlets that it is easily overlooked, except when in flower (Fletcher 1996; Lunt *et al.* 1998). *Amyema linophyllum* is considered vulnerable in Victoria (Lunt *et al.* 1998), although Calder (1983) suggested that mimicry has caused its under-representation in many surveys. Fletcher (1996) reported heavy infestation of *A. linophyllum* on roadside Buloke and Calder (1997) described the species as 'a local problem' in areas of Victoria. This suggests either a recent increase in localised populations of *A. linophyllum*, particularly in disturbed remnants, or improved recognition of the mistletoe species.

Lysiana exocarpi, the Harlequin Mistletoe, has a much wider host range than *A. linophyllum*, including species of *Casuarina, Acacia, Cassia, Exocarpus*, exotic trees and even other mistletoes (Calder 1997). It is easily recognised on Buloke due to the bright green, broader foliage, and the dense clumps that can weigh down the Buloke branches. Large dead haustoria are common on fallen Buloke limbs, suggesting limb abscission in response to mistletoe parasitism (Race and Stelling 1997).

Harlequin Mistletoe is widespread and abundant, but is not regarded as a problem species. However, Calder (1997) noted that reports of heavy infestations are common, suggesting that parasitism by *L. exocarpi* may be increasing. Population explosions of mistletoe plants along roadside verges and disturbed vegetation remnants are well documented in Australia (May 1941; Kenneally 1973; Norton and Smith 1999). For example, Lamont and Southall (1982) recorded ten times as many mistletoe (*Amyema preissii*) individuals per potential host (*Acacia acuminata*) along a roadside than in an adjacent nature reserve.

Increased mistletoe infestation of tree species on roadsides and in disturbed environments has been attributed to various causal factors, depending on the locality and vegetation type. These include increased water run-off from roads (Norton and Smith 1999), increased nutrient availability (Cale and Hobbs 1991; Van Schagen *et al.* 1992), reduced incidence of hot fires (May 1941; Gill and Moore 1993; Gill 1996) and increased host stress due to drought, insect or fungal attack and soil compaction (Calder 1983). Birds play an important role in mistletoe dispersal; reduced numbers of perching sites in an area may encourage flight along roadside corridors (Lamont and Southall 1982; Saunders and de Rebeira 1991), while ageing host trees provide conditions favourable to the Mistletoebird *Dicaeum hirundinaceum* and other pollinating bird species (Calder 1983). If these birds in turn displace mistletoe control agents, such as possums, defoliating insects and other frugivorous birds that are less effective in dispersing mistletoe seed (Thomas 1997), an increase in mistletoe population may result. Physical removal of mistletoe has been minimal due to the risks and costs involved (Fagg 1997). Fletcher (1996) recorded an increased incidence of mistletoe on roadside Buloke, but was unable to identify the cause.

The effects of mistletoe parasitism on *Allocasuarina* spp. have not been reported, but studies on *Eucalyptus* hosts (Kerr 1925; Nicholson 1955; Race and Stelling 1997) indicate that mistletoe reduces vigour and increases host mortality. Preston (1977) and Knutson (1983) found an inverse relationship between host vigour and the number of mistletoe plants per host, and Knutson (1979) concluded that damage to mistletoe-infested trees was due to parasite induced water deficits. In a survey of farm trees in northern NSW, 24% of heavily infested *Eucalyptus blakelyi* died in 33 months (Reid *et al.* 1994). In trees with 50% of crown occupied by mistletoe, the average increment in branch diameter was about half that of uninfested trees.

There is also evidence, however, that mistletoe parasitism is not harmful to the host. Assessment of 208 eucalypts carrying indigenous mistletoes around Melbourne found that 57% were healthy and there was no correlation between host health and the number of mistletoe plants (Race and Stelling 1997). These authors concluded that mistletoe is not necessarily harmful, but forms a symbiotic relationship with the host in times of low environmental stress. The suggestion that mistletoe may only be detrimental in times of stress has received limited attention. Stewart and Press (1990) noted that high transpiration rates of xylem feeding mistletoes affect the water balance of the host, but concluded that the level of water stress depends on water availability; in a dry environment, mistletoe parasitism may kill the host, while in areas of high rainfall, the effects may be negligible. Similarly, Ullmann *et al.* (1985) found that water use by mistletoe is disadvantageous only if the host is severely damaged or senescent. In areas of minimal ecological stress, the minor impact of mistletoe supports the conclusion that mistletoe is not a problem but rather a symptom of ecological imbalances (Thomas 1997).

Conclusions

Galls

Although the gall-inducers on Buloke have been identified and studied since 1892, questions remain about the morphological variability of the galls, while their effect on Buloke vigour and mortality has not yet been investigated. These effects will depend on the level of infestation, which in turn may be influenced by host vigour and thus by environmental factors. Surveys of gall infestation in Buloke remnants in conjunction with environmental assessments are therefore a high priority. In addition, research is needed to study the lifecycle of *C. casuarinae* in relation to the phenology of Buloke growth and reproduction, and assess the biocontrol activity provided by secondary gall colonisers. Only then will informed decisions be possible regarding the necessity or otherwise for gall management and appropriate management methods. In the meantime, restoration and protection of these old and isolated Buloke remnants would be prudent.

Mistletoe

It is unclear whether mistletoes pose an immediate threat to the conservation of Buloke, but the potential for high rates of parasite recruitment and host tree mortality is present, especially in damaged roadside corridors and in isolated stands. On-going surveys of the distribution and abundance of mistletoe on Buloke together with assessment of host vigour are needed to determine whether the host-parasite relationship is changing. It must also be recognised that *A. linophyllum* and *L. exocarpi* are important components of the indigenous flora and in turn provide habitat and food for indigenous fauna (Yan 1993). Hence mistletoe control methods cannot be based simply on eradication, but must focus on management to restore the ecological balance and sustain a healthy equilibrium between mistletoe and their Buloke hosts. This requires ecological and physiological studies of the interaction between the mistletoe species and Buloke.

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Opportunistic Vertebrate Predation by the Squirrel Glider *Petaurus norfolcensis*

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Abstract
The Squirrel Glider *Petaurus norfolcensis* is classified as an exudivore/insectivore feeder, with staple dietary items including insects, insect exudates and plant exudates. During a study of the foraging ecology of the species in northern Victoria, an adult female glider was observed to harass a nesting Common Bronzewing *Phaps chalcoptera*, ultimately removing the bird before consuming eggs within the nest. A description of this observation is provided and vertebrate predation by the Squirrel Glider is discussed in relation to other published accounts. Vertebrate predation by the Squirrel Glider is considered infrequent and opportunistic, but may provide an additional protein and energy source for lactating females. (*The Victorian Naturalist* **118** (4), 2001, 123-126.)

Introduction

The Squirrel Glider *Petaurus norfolcensis* (Fig. 1) is an arboreal, gliding possum of eastern Australia with a distribution extending from northern Queensland to Victoria (Menkhorst 1995; Suckling 1995a). The species is considered endangered in Victoria and is listed under the Victorian *Flora and Fauna Guarantee Act 1988* (DNRE 2000).

The diet of the Squirrel Glider is similar to that of its Australian congeners the Sugar Glider *Petaurus breviceps*, Mahogany Glider *Petaurus gracilis*, and Yellow-bellied Glider *Petaurus australis* (Menkhorst 1995; Strahan 1995). All are classified as exudivore/insectivore feeders with dietary items including plant exudates (e.g. eucalypt sap), insect exudates (e.g. honeydew), and insects themselves (Smith 1982; Goldingay 1986; Kavanagh 1987; Howard 1989; Quin *et al.* 1996; Carthew *et al.* 1999; Jackson 2001). More specifically, studies of the diet of the Squirrel Glider have found the species to rely on nectar and pollen, sap, *Acacia* gum, *Acacia* seeds and arils, fruit, lichen, manna, honeydew, and invertebrates as food sources (Menkhorst and Collier 1987; Suckling 1995a; Holland 1998; Sharpe and Goldingay 1998). The diets of all Australian petaurids tend to be opportunistic, with the importance of individual dietary items varying both temporally and spatially.

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The following is a description of an observation of an individual Squirrel Glider preying upon a vertebrate animal. Such accounts are rare in the literature for both Squirrel Gliders and petaurids in general, particularly concerning free-ranging animals. The observation was made during a detailed study of the foraging ecology of the species in northern Victoria.

Vertebrate predation observed in the Squirrel Glider

To study the foraging ecology of the Squirrel Glider, individual animals were fitted with radiocollars and data was collected via direct timed observations. The study was conducted along a strip of remnant roadside vegetation in the northern plains of Victoria, near Euroa. Vegetation along the road reserve forms an open woodland dominated by Grey Box *Eucalyptus microcarpa* (Ross 2000).

On the night of 12 November 1998, observations were made of an adult female

Fig. 1. Squirrel Glider *Petaurus norfolcensis*. Photo by John Seebeck.

glider, known to be carrying a single, furless pouch young, approximately 2.5-3.0 cm in length (crown-rump).

At 2228 hours the glider approached a nesting Common Bronzewing *Phaps chalcoptera* (Higgins and Davies 1996). The nest was located in the fork of a near horizontal Grey Box branch approximately 10 m above the ground. The Common Bronzewing became very distressed as the glider sniffed the edge of the nest. Facing the glider, the bird rapidly flapped its wings while remaining on the nest. This behaviour did not deter the Squirrel Glider, which then forced its head beneath the bird for a short period. At 2231 hours the glider moved past the nest and sat stationary on the same branch, approximately one metre distant. The Common Bronzewing ceased its wing flapping and remained on the nest. After one minute the glider again approached, sniffing the nest and pushing its head under the bird as above. Again the Common Bronzewing became severely agitated and resumed its wing flapping. This continued for a period of one minute before the Squirrel Glider again moved approximately one metre past the nest and sat stationary. After a further one minute of inactivity, the glider moved towards the nest once more and continued harassing the Common Bronzewing. After 20-30 seconds the Common Bronzewing vacated the nest, flying to a nearby tree. The Squirrel Glider then moved approximately half a metre from the nest and sat stationary for one minute. It then moved back, placing most of the front half of its body into the nest. For a period of 10 minutes the glider remained in this position, moving only its head in a licking motion. During this time it was inferred that the Squirrel Glider broke the shell and consumed the contents of eggs within the nest. At 2246 hours the glider left the nest and engaged in other activities.

Inspection of the nest the following morning found no trace of eggs. However, an eggshell was found on the ground almost directly beneath the nest. This eggshell had a neat, narrow incision on one side and was completely void of contents. It is possible that this egg had been consumed by the Squirrel Glider the previous night.

Discussion

Although classified as an exudivore/insectivore feeder, this observation indicates that the Squirrel Glider is capable of preying upon the eggs of nesting birds. Similar accounts of vertebrate predation by free-ranging Squirrel Gliders are uncommon. Winter (1966) described a remarkably similar observation of a Squirrel Glider attacking a nesting Magpie-lark *Grallina cyanoleuca* near Brisbane, Queensland. Prior to consuming the eggs the glider bit the adult bird and lifted it from the nest using its teeth. The Magpie-lark later died from injuries inflicted by the glider. In their investigation of the diet of the Squirrel Glider in Victoria, Menkhorst and Collier (1987) found feather fragments in the faecal samples of several individuals. The absence of bone fragments created doubt as to whether the gliders in question had killed and eaten roosting birds. Hence, it was hypothesised that feathers may have been inadvertently ingested while consuming bird eggs (Menkhorst and Collier 1987).

Fleay (1947) described the carnivorous tendencies of Squirrel Gliders, Sugar Gliders, and hybrids of these two species in captivity. All were observed to attack small birds placed in their enclosures. Sugar Gliders were also responsible for the consumption of a House Mouse *Mus domesticus*. Published accounts of vertebrate predation by wild Sugar Gliders are rare, despite much work having been done for the species. McKenzie *et al.* (1977) observed a Sugar Glider eating a Peaceful Dove *Geopelia striata* in the Kimberley region of Western Australia.

The above indicates that both the Squirrel Glider and Sugar Glider include avian prey in their diet, if only infrequently. Both are known to attack small birds in the wild and in captivity, and there are now two accounts of free-ranging Squirrel Gliders consuming bird eggs. There is no published information relating to vertebrate predation for the Mahogany Glider or Yellow-bellied Glider.

All previous accounts of avian predation for both the Squirrel Glider and Sugar Glider have involved a direct physical attack on an adult bird. In this observation, the Squirrel Glider made no attempt to physically attack the nesting Common Bronzewing. It is possible that the larger size of the Common Bronzewing (28-36 cm, 320-350 g; Higgins and Davies 1996), in relation to the Squirrel Glider (18-23 cm excluding tail, 190-300 g; Suckling 1995a), deterred the glider from making a direct physical attack. The Magpie-lark (26-30 cm, 75-95 g; Pizzey and Knight 1999; W. Boles, Australian Museum, Sydney, *pers. comm.*) is considerably lighter than the Common Bronzewing, and is the only species recorded as a victim to a Squirrel Glider attack in the wild (Winter 1966). Similarly, recorded avian victims of the Sugar Glider (16-21 cm excluding tail, 95-160 g; Suckling 1995b) have been comparatively small (Peaceful Dove: 20-24 cm, 41-66 g; European Blackbird *Turdus merula*: 25-25.5 cm, 75-95 g; Fleay 1947; McKenzie *et al.* 1977; Boles 1988; Higgins and Davies 1996).

The diet of petaurid possums is considered to be low in protein, with plant and insect exudates such as sap and honeydew being rich in carbohydrates but containing little protein. Hence, such possums must include protein-rich food items such as arthropods and pollen in their diet to meet their protein demands (Smith 1982; Quin *et al.* 1996; Jackson 2001). Protein is a particularly important dietary component during reproduction, with lactating females requiring increased protein intakes (Smith 1982; Henry and Suckling 1984; Suckling 1984; Goldingay 1986; Sharpe and Goldingay 1998). Several authors have found that petaurids time their reproductive efforts so that lactation occurs when protein-rich food sources (i.e. pollen and/or arthropods) are most abundant (Smith 1982; Suckling 1984; Quin 1995; Jackson 2001). Smith (1982) observed the Sugar Glider to forage for arthropods in preference to plant exudates while lactating, despite the abundance of exudates during the same period.

The Squirrel Glider in this observation was a female carrying a single pouch young, and most faecal samples identified as containing feather fragments by Menkhorst and Collier (1987) were from female gliders. Female gliders may engage in egg predation when provided with the opportunity in order to facilitate lactation. Not only are bird eggs rich in protein, they are also rich in fats that would assist lactating animals in satisfying increased energy demands (Green 1997). The risk of injury associated with attacking and/or removing the parent bird may make egg predation less worthwhile for male gliders and non-lactating females given their lower protein and energy requirements.

Vertebrate predation by the Squirrel Glider (and Sugar Glider) appears to be opportunistic. Despite observing Squirrel Gliders for in excess of 3 000 minutes over the course of a year, only one incidence of vertebrate predation was recorded. Hence, it is unlikely that the Squirrel Glider actively searches for vertebrate prey in the course of general foraging activities. Instead, it is concluded that gliders capitalise on vertebrate prey only when suitable targets are encountered by chance whilst foraging for more abundant and reliable food sources. This explains the dearth of records for such behaviour.

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Human and Natural Impacts on the Upper Yarra Region with Reference to the Yellingbo Nature Conservation Reserve: a Review

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Abstract

The Upper Yarra Valley and Dandenong Ranges region has a rich and diverse social history. Past and current land management activities, including gold mining, timber harvesting, agriculture, and urban development, have fragmented and degraded the landscape. Currently, there is a wide range of agricultural and horticultural activities within the region, some of which are in decline (e.g. dairy farming) whilst others are expanding rapidly (e.g. grape production).

The Yellingbo Nature Conservation Reserve is situated within the Shire of Yarra Ranges and is best known as the last remaining habitat of the Helmeted Honeyeater *Lichenostomus melanops* subsp. *cassidix*, Victoria's official State bird emblem. The general land use activities within the Shire of Yarra Ranges are reflected in changes in land use in areas bordering the Yellingbo Nature Conservation Reserve. Over the past fifty years there has been a marked reduction in the area of native forest (from 47 to 13%) and a corresponding increase in pasture based activities (from 53 to 83%) and some intensive horticulture (0 to 4%). With current revegetation strategies and ongoing land purchases, there will be a gradual increase in forested areas bordering the Yellingbo Nature Conservation Reserve. (*The Victorian Naturalist* **118** (4), 2001, 127-139.)

Introduction

In 1982 a report was produced for the then Fisheries and Wildlife Division entitled *A Historical Survey of Yellingbo* (Curtis 1982). The following review is loosely based on this report but provides more detailed historical information and has been substantially updated to incorporate more recent events and material.

The Yellingbo Nature Conservation Reserve (YNCR) is located approximately 48 km east of Melbourne (37°47' S, 145°32' E; altitude 70-120 m above sea level) within the Shire of Yarra Ranges, a region that covers a total of 276 000 ha. The Shire of Yarra Ranges was formed in December 1994 and now oversees the majority of land previously included within Shires of Lilydale, Sherbrooke, Upper Yarra and Healesville (Fig. 1).

This paper begins with a general description of the Yellingbo Nature Conservation Reserve. This is followed by the natural history of the region that includes the origin of the township of Yellingbo, land settlement and past natural events such as fires, floods and droughts. The physiography, geology, and soils of the region are then discussed. The paper concludes with a general description of land use activities within the Shire of Yarra Ranges and a historical account of changes in land use activities surrounding the YNCR.

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Yellingbo Nature Conservation Reserve

The YNCR was created in May 1965 to protect the habitat of one of the few remaining populations of the Helmeted Honeyeater, *Lichenostomus melanops* subsp. *cassidix* (nomenclature after Christidis and Boles 1994), Victoria's bird emblem. At that time, the YNCR was only 170 ha in size but has since grown with subsequent purchases to 591 ha. The YNCR now supports the last remaining population of the Helmeted Honeyeater (approximately 100 individuals) following the extinction of relict groups at Cardinia Creek and near the township of Cockatoo around the time of the 'Ash Wednesday' wildfires in February 1983 (Smales *et al.* 1990).

YNCR is situated in a sheltered valley system between the Dandenong and Great Dividing Ranges, the former providing a high-rainfall catchment for the permanent streams in the YNCR. The climate is cool-temperature. Mean daily maximum temperatures range from 13.6°C in winter to 25.6°C in summer (YNCR 1988-1994

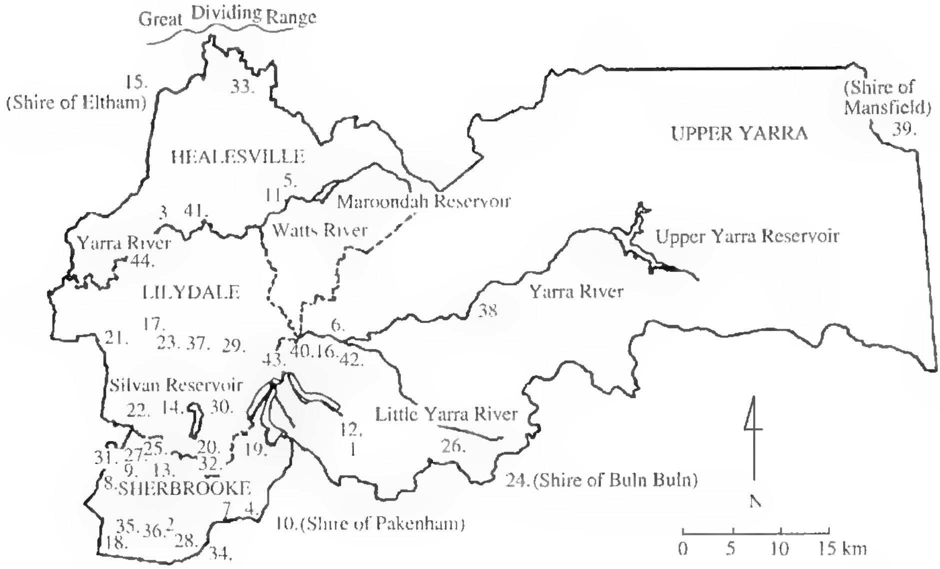

Fig. 1. The Shire of Yarra Ranges. Solid line major rivers, Dotted line boundaries of the former Shires of Lilydale, Healesville, Sherbrooke, Upper Yarra and Dandenong Ranges, Shaded region The Yellingbo Nature Conservation Reserve. Localities mentioned in the text are indicated by corresponding numbers. Localities: 1. Beenak; 2. Belgrave; 3. Christmas Hills; 4. Cockatoo; 5. Coranderrk; 6. Don Valley; 7. Emerald; 8. Ferntree Gully; 9. Ferny Creek; 10. Gembrook; 11. Healesville; 12. Hoddles Creek; 13. Kallista; 14. Kalorama; 15. Kinglake; 16. Launching Place; 17. Lilydale; 18. Lysterfield; 19. Macclesfield; 20. Monbulk; 21. Mooroolbark; 22. Mt Dandenong; 23. Mt Evelyn; 24. Noojee; 25. Olinda; 26. Powelltown; 27. Sassafras; 28. Selby; 29. Seville; 30. Silvan; 31. The Basin; 32. The Patch; 33. Toolangi; 34. Upper Beaconsfield; 35. Upper Ferntree Gully; 36. Upwey; 37. Wandin; 38. Warburton; 39. Woods Point; 40. Woori Yallock; 41. Yarra Glen; 42. Yarra Junction; 43. Yellingbo; 44. Yering.

inclusive; DNRE *unpubl. data*). The annual rainfall is approximately 1 100 mm which falls throughout the year with peaks in winter and spring. There are generally fewer than ten frosts each year but fogs may persist for much of an estimated 50 to 100 days each year (McMahon and Franklin 1993).

The YNCR encompasses narrow strips of riparian and swamp vegetation along the Woori Yallock, Cockatoo, Macclesfield and Sheep Station Creeks (Fig. 2) that are dominated by Mountain Swamp Gum *Eucalyptus camphora*, Swamp Gum *E. ovata* and Manna Gum *E. viminalis* (nomenclature for all flora species after Ross 1996). YNCR includes the largest and most intact example of *E. camphora* swamp woodland in Victoria, a 170 ha drainage basin along the lower reaches of the Cockatoo and Macclesfield Creeks (McMahon *et al.* 1991). This swamp is subject to seasonal inundation which lasts from three to ten (or more) months per year (McMahon and Franklin 1993). Much of the swamp was formerly used for agriculture (Backhouse 1987).

Tree decline is a serious problem throughout the YNCR and most of the eucalypts (*E. camphora, E. ovata, E. viminalis,* Green Scent Bark *E. fulgens*) display symptoms of decline or dieback (McMahon *et al.* 1991). In 1991 an estimated 25-30% of the eucalypt canopy was affected by dieback (McMahon *et al.* 1991). Dieback is particularly severe within the swamp and in 1991 approximately 30% of the swamp was affected by dieback (McMahon and Franklin 1993). Since 1991 a further 12% of the swamp has been affected by dieback, and 20% of the affected trees (predominately *E. camphora*) are dead (Carr 1998; Craigie *et al.* 1998). Most of the land bounding the YNCR is cleared

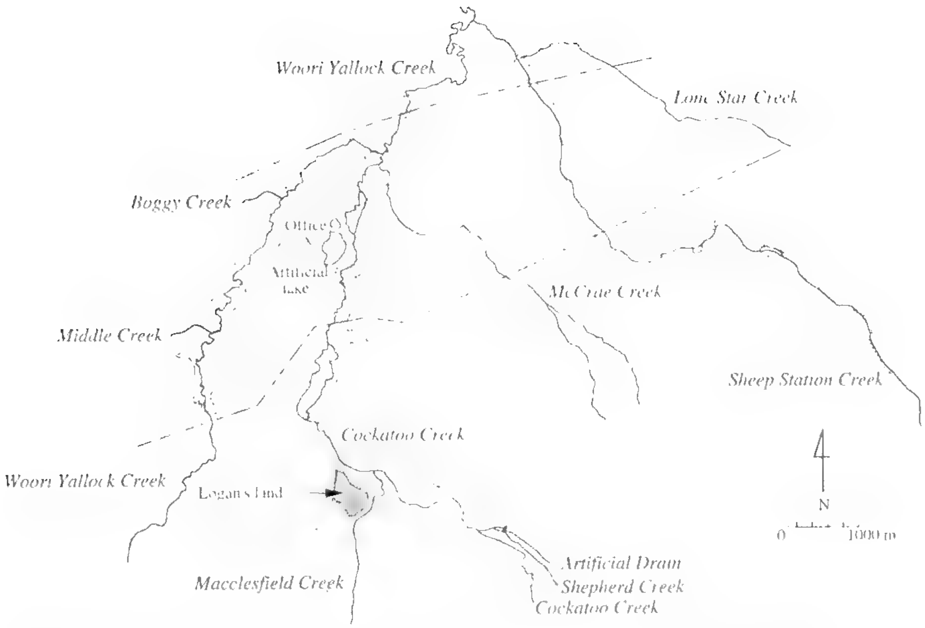

Fig. 2. The Yellingbo Nature Conservation Reserve. Solid line, water course, Dotted line, reserve boundary (as it stood in 1995), Dashed line, Melbourne Water pipeline.

or semi-cleared farmland and uses include cattle grazing, hobby farming, market gardening, poultry and pig farming. A large artificial lake adjacent to the northern end of the Cockatoo Creek forms part of a holiday ('Way of Life') camp. Two Melbourne Water pipeline easements cut through the YNCR; one crosses the Cockatoo Creek in the central part of the YNCR, while the other runs adjacent to the northern end of the Woori Yallock Creek before it crosses the YNCR just after these two creeks converge (Fig. 2). The Macclesfield-Woori Yallock Road runs between the Woori Yallock and Cockatoo Creeks and crosses the YNCR just north of their junction.

History

Aborigines

Immediately prior to the arrival of European settlers, four major groups of Aborigines occupied what is now the Shire of Yarra Ranges. The Aboriginal groups included the Boonurrong, Moonoba Ngatpan, Taoungurong and Wawurrong (or Woewurrong) people (Smyth 1878). Most of the region (which includes Yellingbo) was the territory of the Wawurrong people and was more or less continuously inhabited. The Wawurrong laid claim to all the land included within the basin of the Yarra River and the Dandenong Ranges. The boundaries followed the course of the Maribyrnong River in the west, the dividing range to the north, the mountains containing the sources of the Yarra in the east and the mountains lining the Yarra basin in the south.

In 1838, the number of Aborigines who inhabited the region was estimated to be 205 members of the whole Wawurrong tribe and 87 of the Boonurrong tribe. Before Melbourne was settled in 1835, the aboriginal population would have been larger, but was always small (Tansley 1978; Carroll 1988).

Archaeological evidence and reports from early European settlers suggest that Aborigines preferred the river flats around present-day Yarra Glen and Yering and the foothills around Lilydale and Mooroolbark. Mountainous areas with rough and densely-forested terrain and cold, wet winters were avoided and only visited in summer to obtain specific products and to maintain contact between distant tribes (Tansley 1978).

The Aborigines were a hunter-gatherer community, living well on the river flats and in the foothills where game was abundant. They were semi-nomadic and roamed the countryside in small tribal groups in search of game. Their diet consisted of animals such as possums, kangaroos, various water-birds and fish and vegetables such as the roots of small plants and a variety of fruits and seeds (Aveling 1972).

Not long after the arrival of European settlers, reserves were created for the purpose of protecting the Aborigines from the settlers, many of whom were ruthless in dealing with the Aborigines. The largest Aboriginal station in Victoria was Coranderrk, near Healesville. The reserve was established in 1863 on 930 ha of land between Badger Creek and the Watts River. In 1868, the reserve was enlarged to 1 960 ha and by 1878, the population had reached 148 (Massola 1975). In 1922 the reserve was officially closed and most of the remaining inhabitants were taken to Lake Tyers and Coranderrk was subdivided for soldier settlement.

The township of Yellingbo

Yellingbo was originally known as Claxton after James Claxton, one of the earliest settlers in this particular portion of the Yarra Ranges Shire. Claxton's title to land on the outskirts of the future township of Yellingbo became permanent in 1883 and he erected a solid weatherboard building near the Woori Yallock Creek that served as wine salon, post office and store for a number of years. Groceries were brought each week to Claxton from Lilydale by bullock wagon (Coulson 1959).

After marrying Elizabeth Parslow, James Claxton moved to Melbourne to live. By 1888 all the titles had passed to Elizabeth's brother, Henry Parslow. The locality soon became known as Parslow's Bridge, or simply Parslow's. During that period, a grocer from Seville called at the store weekly, while mail was carried by a horseback rider twice a week (Coulson 1959; Carroll 1988).

The post office, known as Parslow's, was operated for many years by members of the Parslow family. For some time the wine hall was also the post office but by 1918 had been moved to Mrs Ellen Parslow's property. A telegraph and telephone office opened there on 3 February 1921. Christopher John Parslow (nephew of the original selector) took over the post office on 14 November 1925. In the early 1940s, the original building was replaced and the post office transferred to its existing site. In March 1952 Christopher Ian Parslow took over functions in the post office. On 12 August 1946 the locality was renamed Yellingbo (which means 'today') after the last Aborigine to have frequented the district (Coulson 1959; Carroll 1988).

Land settlement

European settlement of the region began in 1837 with the arrival of the Ryrie brothers. They travelled overland from New South Wales with a large herd of cattle and settled on the lush river flats near the future site of Lilydale and called their property by its Aboriginal name, 'Yering'. They took up a grazing licence on 17 000 ha of the most fertile land between Woori Yallock and Olinda Creeks on the south side of the Yarra. Once established, the Ryries extended their grazing licence and established two outstations on the north bank of the Yarra (Marriott 1975; Tansley 1978; Curtis 1982; Carroll 1988).

A number of pastoral leases were taken up in the Upper Yarra Valley between 1835 and 1851 (Fig. 3). 'Elgars' and 'Unwins', were taken up soon after settlement and subsequent leases included: the 'Gulf' along Dixons Creek, north of the present day township of Yarra Glen; 'Christmas Hills' (which was close to the present day settlement of the same name); 'Steels Flat' along the Wandin Yallock Creek valley; and 'Solitude' along the Woori Yallock Creek valley (Marriott 1975; Tansley 1978). Of these, Steels Flat and Solitude are of most interest since they were in the vicinity of Yellingbo (Curtis 1982).

Steels Flat is believed to have been part of Ryrie's outstations (Curtis 1982) and was farmed by Robert Brierty, followed by Peter Kerr and David Mitchell (Curtis 1982). David Mitchell cleared the land, introduced English pasture species, and began dairying

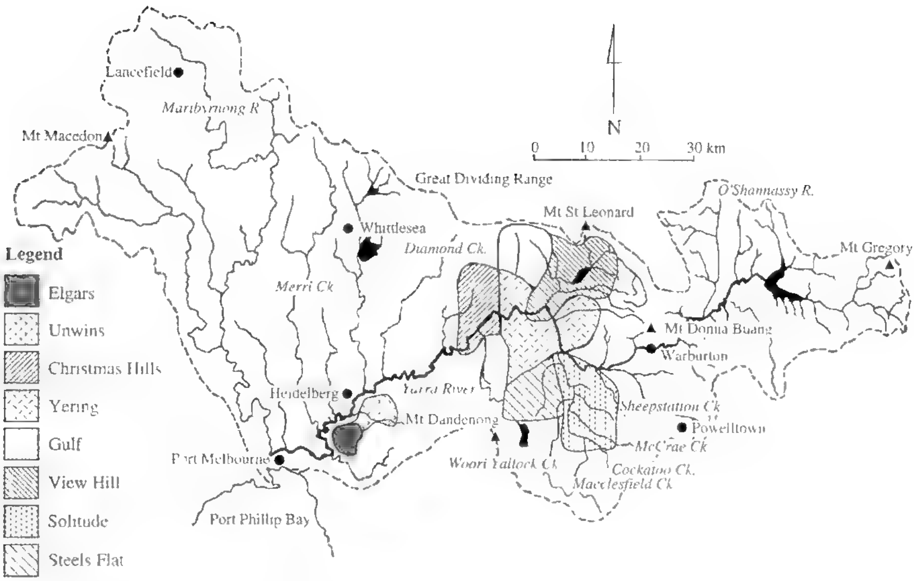

Fig. 3. Pastoral leases of the Yarra Valley, 1835-1851 (modified from Marriott 1975). The various leases are indicated by differently shaded areas (see legend). The Yellingbo Nature Conservation Reserve is located within Steels Flat and Solitude Run. This map shows the Yarra Valley defined on the basis of the watersheds of the Yarra River and its tributaries. Dashed line, catchment boundaries. Black areas, water storage reservoirs.

and cheesemaking. In the 1880s, David Syme took over the area and divided it into two parts called Killara and Dalry (Curtis 1982).

Solitude Run in the Hoddles Creek area is also thought to have been part of Ryrie's outstations (Curtis 1982). In 1846, James Cavanagh operated the 11 580 ha Solitude Run which was to change hands frequently – some nine times in 20 years (Curtis 1982). Each successive owner had the right to farm the Solitude Run, however its lower reaches, where Yellingbo is situated today, were not cleared and developed until the 1880s (Curtis 1982). The pastoralists preferred to graze their cattle on the river flats rather than in the timbered regions (Tansley 1978). The following statement held true until the days of the Land Settlement Act: 'It was only around the homesteads that the mark of the man was much apparent; here the land was cleared both for its timber and to plant kitchen gardens' (Aveling 1972). Housing was mostly made from local materials. Most of the homesteads were constructed from hand-hewn wooden slabs and had shingle roofs.

In the 1880s, the Land Settlement Act was introduced to Parliament with the aim of providing the 'everyday working man' with an opportunity of obtaining land for a low cost, under the condition that he clear and work the land. The proclamation of the act provided the impetus for 'development' of land throughout Victoria. An inspector would visit the settlements monthly to police this agreement. Clearing was slow and patchy and eventually many of the settlements were abandoned and cleared areas returned to scrub (Curtis 1982).

Gold mining

The Shire of Yarra Ranges was the site of several gold rushes. During the 1860s and 1870s there was a great deal of mining in the Upper Yarra Fields. Gold was first discovered in Emerald in November 1858 (Marriott 1975; Curtis 1982). News of the find brought some 60 miners rushing to the district at a time when the remainder of the area was populated by timber workers and pastoralists living in the foothills. Five months later a total of 1 000 miners were living on the goldfields of Emerald (set around the junction of Woori Yallock and

Menzies Creeks) (Coulson 1959; Fleet 1970; Curtis 1982). By 1861 only 52 miners remained at the Emerald Goldfields since news of fresh discoveries elsewhere 'constantly sent miners packing – virtually overnight' (Coulson 1959).

Gold was discovered at Macclesfield (south of Yellingbo) in either 1864 or 1865 when prospectors from the abandoned Emerald diggings began working their way along the creeks in the area (Coulson 1959). The original prospecting era lasted only a short period but 30 years later a second find in Smith's Creek by four men picking *Eucalyptus* leaves began a small gold rush that lasted five years. A considerable quantity of gold was removed from Macclesfield during the 1890s. The majority of the gold mining in this area was alluvial, although there were some quartz claims (Coulson 1959; Fleet 1970; Curtis 1982).

Gold mining is now a minor activity in Shire of Yarra Ranges. The only operational mine of any type is a small but inactive gold mine at Hoddles Creek (Christoff and Wishart 1994).

Saw milling

Tree fellers arrived in the Yering and Mooroolbark area in the early 1840s. By the early 1850s they had cleared the Yering and Moorolbark areas and moved up the Olinda Creek valley into the Dandenong Forest. Saw milling was a large industry by the 1920s serving the booming housing industry in Melbourne. During this time, the Gembrook, Beenak and Hoddles Creek areas were the sites of most of the mills (Tansley 1978; Curtis 1982). The number of sawmills reached a peak of 241 in 1921, and then declined steadily, especially after 1924, to 169 in 1930 (LCC 1991).

Timber from the present YNCR area was transported to the railway at Woori Yallock. A timber tramline followed the Sheepstation Creek through what is now the YNCR (Curtis 1982). Land was cleared for the construction of lines for the horse drawn trams and the felled timber was used there and then to construct the lines (Curtis 1982).

In the vicinity of the present-day YNCR office in Shaw Road, a sawmill was operated by the Moore family in the 1930s. Other properties in the area had small mills for their own use (Curtis 1982).

The disastrous fires of 1939 left a large death toll because people were stranded at the many isolated sawmills. The period of timber tramlines and isolated sawmilling settlements came to an end with the post-fire introduction of new regulations requiring that mills be located in towns. The few tramlines and isolated mills that survived the 1939 fires have decayed or have been destroyed. Currently there are 22 sawmills in the Shire of Yarra Ranges (Christoff and Wishart 1994).

The railway

In 1881 the Melbourne to Lilydale railway was completed. This opened the area to tourists and allowed local produce to be transported to Melbourne. The railway line was extended to Healesville in 1889 and boosted development of that township. Construction of a further broad gauge railway line from Lilydale to Warburton in November 1901 provided great advantages to the region surrounding Yellingbo and grazing country around Woori Yallock developed. Dairying was popular along the flats of Launching Place and Don Valley and the orchards surrounding Wandin and Sevillle became more prosperous (Tansley 1978; Curtis 1982).

Fire

The Shire of Yarra Ranges ranks among the most fire prone area in the world. Major fires swept the area in 1851, 1898, 1926, 1932, 1939, 1962 and 1983 (Table 1). The bushfires of 14 February 1926 killed seven people and large numbers of livestock. A considerable portion of the region was burnt during 1932 but those fires were minor by comparison with the 'Black Friday' fires on 13 January 1939.

The 1939 fires raged across much of Victoria burning vast areas of forest (approximately 1.4 million ha) and pasture and claiming 71 lives. The Mountain Ash *E. regnans* and Alpine Ash *E. delegatensis* forests of the Upper Yarra were severely burnt.

On 13 February 1983, the 'Ash Wednesday' bushfires again burnt through much of the Shire of Yarra Ranges. Victoria was possibly in the midst of its worst drought.

Table 1. Major fires in the forested public land of the Upper Yarra Valley and Dandenong Ranges Region (after McHugh 1991).

Date	Name	Location
1851	*Black Thursday*	Widespread
1880		Basin/Olinda
1898	*Red Tuesday*	Kallista - The Patch - Selby; Gippsland
1908		Powelltown
1913		Sassafras - Monbulk
1918		Healesville
1923		Belgrave - Upwey - Ferny Creek
1926		Monbulk; Powelltown/Healesville
1932		Powelltown
1934		Basin - Ferntree Gully
1939	*Black Friday*	Widespread
1944		Basin - Ferntree Gully
1954		Upper Ferntree Gully
1962		Basin - Sassafras - Ferny Creek; Gembrook; Olinda Creek; Mt Evelyn; Kalorama
1968		Basin - Upwey; Basin - Sassafras - Ferny Creek
1972		Lysterfield
1983	*Ash Wednesday*	Warburton/Powelltown; Belgrave South - Upper Beaconsfield; Cockatoo
1991		Warburton
1997		Mount Dandenong; Sassafras - Ferny Creek

For example, in 1982, Warburton had its lowest rainfall since 1972, with just 1 026 mm compared with the average of 1 344 mm. Inflow into the Yarra River system in spring had only been about a quarter of the average and far less than that in the previous severe drought in 1967-68.

In excess of 180 000 ha of forest and pasture were severely burnt in the Ash Wednesday fires. In the Warburton area, fire damage was severe. About 36 000 ha were burnt in the area roughly bounded by Yarra Junction, Powelltown (west of Noojee), Upper Yarra Dam and Warburton. Much of this area had burned in the 1939 bushfires and the Mountain Ash forests had regenerated in the 43 years since.

A settler in the area of Yellingbo by the name of Walsh, reported that his fences and crops were damaged severely by bushfire during 1898, when Gippsland along with much of the remainder of the State was ablaze. It is feasible then, that the 1898 fire encompassed parts of Yellingbo. Beenak, a few kilometres to the southeast of the YNCR, was badly burnt by the fire (Curtis 1982).

The major fires affecting Yellingbo were those of 1926 and 1939 (Curtis 1982). According to a local resident, Mr Alec Ferguson, the blaze of 1939 extended from Healesville to Woods Point (Curtis 1982). Spot fires erupted in the Yellingbo area, caused by falling ash. Another local resident, Mr Hubert Champion, recalls that the area ranging from Parslow's through the Cockatoo Swamp was burnt at this time and that until World War II, the swamp was deliberately burnt on a regular basis (Curtis 1982). Mining records support these interpretations; Protective Registration (a means of formally requesting protection from fires and other natural disasters) was applied for in January and April, 1939 (Curtis 1982).

No fire on the scale of the 1939 'Black Friday' has been reported for the Yellingbo area in the post World War II period. In 1962 a fire extending from Sheepstation Creek-Hoddles Creek-Gembrook, claimed the lives of four of the Ockwell family at Woori Yallock, but apparently did not burn much of the present YNCR (Curtis 1982).

Floods

Evidence of severe floods was noted by Grimes (surveyor-general of New South Wales who surveyed the shores of Port Phillip Bay) when he arrived in 1803 and houses and properties of the first settlers at Melbourne were flooded within a few years of their arrival. Between the years 1839 and 1954, a total of 80 floods were recorded for the Upper Yarra Valley (Bureau of Meteorology 1955; Curtis 1982).

Bureau of Meteorology records indicate that on average, some part of the valley is severely flooded every two years and generally in the months of August, September and October – over 50% of all floods have been recorded in these three spring months. This is the period of greatest rainfall and heavy falls cannot be absorbed by the saturated soils. While most available information deals with the lower reaches of the valley, the alluvial flats around Yarra Glen are perhaps more susceptible to flooding than anywhere else (Marriott 1975).

One of the earliest records of flooding appeared in the 'Melbourne Age' on 16 December 1863. The whole of the Yarra delta was flooded and all the local creeks were in full flood. One man was drowned in Flinders Street in the heart of the city of Melbourne, an indication of the severity of the floods (Curtis 1982).

Since European settlement, the most severe floods in the Upper Yarra Valley were in late November and early December 1934 when a cyclonic storm brought 'hurricane winds, heavy seas and torrential rains' to southern Victoria. Communications were cut and isolated rural settlements far up the valley were literally washed away. Bridges disappeared, factories and homes were flooded, and people drowned. The Melbourne Age, 1 December 1934, described the storm as 'one of the most terrific gales ever experienced in the history of this State'. Land which now forms part of the YNCR was flooded during this time and several farmers in the region lost entire crops to flood waters (Miller and Buckland 1992).

The 1934 flood was recalled by Mr Alec Ferguson, a present-day resident of Yellingbo. According to Mr Ferguson 11 inches (275 mm) of rain fell in 30 hours (Curtis 1982). Mr Ferguson stated that 'the water was four feet above the bridge across the Woori Yallock Creek on the Warburton Highway' (now known as the 'Old Warburton Highway'; Curtis 1982). Mr Hubert Champion, whose family were amongst the early settlers of the region, recalls the damage, 'cows, horses and anything else in the path of the water was washed downstream' (Curtis 1982).

A flood on the scale of 1934 was made less likely by the 'snagging' of the Woori Yallock Creek during the 1930s Depression. In this period, drains were cut at the junction of the Shepherd and Cockatoo Creeks in an effort to reclaim swampy land for agricultural use and to further control flooding. In the early 1950s levy banks were constructed further downstream along the Cockatoo Creek in an attempt to further control water flow and reclaim 'swampy' land (Curtis 1982).

Applications for Protective Registration Certificates under the Mining Act again support the contention that the region is prone to flooding with applications concerned with excess water in: July 1909, March 1934, September 1934, January 1935, November 1936, January 1937, October 1937 and July 1939 (Curtis 1982).

Another Yellingbo resident, a member of the original Parslow family, Mr Ian Parslow, recalls that during 1958 water rose approximately two metres above the present road level on Macclesfield-Woori Yallock Road (Curtis 1982) near the confluence of Cockatoo and Woori Yallock Creeks (Fig. 2).

In 1962, floods on a scale of 1934 were made unlikely by the opening of the Upper Yarra Reservoir (see Fig. 1) that traps much of the water previously destined for the Yarra and its tributaries. Heavy local rainfall may still cause local and short-term flooding and records of the Department of Natural Resources and Environment (DNRE) show that even average rainfall could result in water covering the Sheepstation Creek Road for a distance of 50 yards (46 metres). According to Mr Hicks, who has a property on the road, floods in the area are short lived, one to two days on average (Curtis 1982).

Droughts

Droughts are less frequent than floods in the Upper Yarra Valley although their impact is more severe. The Bureau of Meteorology has recorded eight major drought periods for the Upper Yarra Valley-Port Phillip region (Table 2). In each case droughts were not confined to this region but instead were widespread throughout southern Victoria.

Table 2. Major periods of drought in the Yarra-Port Phillip region (Bureau of Meteorology 1955, 1983a, b; after Curtis 1982).

Years	Description
1895-1902	Major rainfall deficiencies, especially in 1895 when rainfall in Melbourne was 432 mm, and in 1898 when the fall was 396 mm (average was 679 mm).
1913-1914	Marked shortages of rain, between May and October 1914, rainfall in Melbourne was 203 mm; the average for that period was 334 mm.
1925-1927	From June 1925 to June 1927, rainfall in Melbourne was about half the average.
1939-1940	Good rains in early 1939 were followed by 12 months of drought, ending in December 1940.
1943-1945	Three years of below average rainfall led to severe stock losses and bushfires.
1967-1968	The most severe drought on record. Beginning in January 1967, it lasted until April 1968. Stock, crop and home garden losses were severe. Between October 1967 and April 1968, rainfall in Melbourne totalled 148 mm instead of the average of 394 mm for these months. The total rainfall for the year of 1967 was 322 mm, the driest since records began in 1855.
1972-1973	A short yet extremely severe drought which began in the winter of 1972 and lasted until late February 1973. During that time, Melbourne faced its most severe water restrictions ever. Rainfall between March and December 1972 was about half the average.
1982-1983	Melbourne's total rainfall in 1982 was 422 mm (average 659 mm); the fourth driest since records commenced and the second driest this century. The eleven month period from April 1982 to February 1983 was the driest on record over most of Victoria (338 mm). In the summer of 82/83, the rainfall total was 78 mm compared with an average of 154 mm. In 1983, Melbourne experienced its hottest February day on record, 43.2°C.

The mining Protective Registration Certificates once again provide some indication of water levels in the Woori Yallock Creek. Water shortages were recorded on the following dates: 19 November 1929, 24 November 1936, 6 February 1937, 6 December 1938, and 10 March 1939 (Curtis 1982).

Physiography

The Shire of Yarra Ranges spans two land systems. These are the *Eastern Victorian Uplands*, which cover most of the region; and the *Yarra Plains*, in the lower reaches of the former Shire of Lilydale (Rowan 1988). The southern edge of the former Sherbrooke Shire is also at the northern margin of the *Basalt Plains* region, as evidenced by a few plant species characteristic of that area such as the Zig-Zag Rush *Schoenus brevifolius* (Christoff and Wishart 1994).

The physiographic evolution of the Shire of Yarra Ranges was governed by combinations of erosion, faulting, warping and volcanic activity. Extensive areas of outcropping bedrock have given rise to areas of high elevation. Prolonged erosion has produced a step-like succession of partially preserved erosion surfaces, the dissection of which has resulted in considerable relief (McAndrew and Marsden 1973). Three main cycles of erosion are recognizable in central Victoria, culminating in turn in the Baw Baw surface, the Kinglake Surface and the Nillumbik Terrain (McAndrew and Marsden 1973). The Shire of Yarra Ranges lies within the Kinglake Surface and the Nillumbik Terrain; of these, the Nillumbik Terrain is the most important.

The Nillumbik Terrain is the prominent erosion surface as shown by the generally concordant height of ridges in the area of Silurian-Lower Devonian bedrock east and northeast of Melbourne. It rises in elevation from about 20 m at Melbourne to about 200 m at the foot of Mt Sugarloaf (40 km northwest of Yellingbo), which is part of the well-defined escarpment at the southern edge of the higher Kinglake Plateau (McAndrew and Marsden 1973). It is also present further east in the Woori Yallock Basin. The Nillumbik Terrain has been dissected by the Yarra River and its tributaries and to a lesser extent by the Dandenong Creek.

Geology

Bedrock comprises a thick sequence of folded Upper Ordovician to Middle

Devonian sediments ranging from mudstone to sandstone with mudstone dominant in the western part of the Shire of Yarra Ranges and sandstone in the east. The western and central parts of the Shire of Yarra Ranges are dominated by thick acid volcanics comprising rhyolite and rhyodacite, and acid intrusives comprising granite and granidiorite of Middle to Late Devonian age (Cooney 1979). Outcrops of Tertiary basalt are found in isolated patches between Lilydale and Hoddles Creek. The basalt is usually highly weathered in outcrops although fresh material up to 50 m thick has been recorded in drill holes (Cooney 1979). Thin Tertiary sediments underlie the basalt in some places. Deposits of Quaternary alluvium and colluvium line major streams such as the Yarra River and the Woori Yallock, Olinda, Cardinia and Dandenong Creeks.

Remnants of erosion surfaces from the Cretaceous, Lower Tertiary and Middle Tertiary ages are present within the region, indicating that such locations have undergone prolonged weathering. The many flat ridges at elevations of about 250 to 350 m reflect the now dissected Nillumbik Terrain (LCC 1973).

The majority of the YNCR lies on Quaternary alluvial deposits of gravel, sand and silt. Within the Woori Yallock Creek and Cockatoo Creek catchments, the dominant geologies are siltstones of Lower Devonian origin to the north, and siltstones of Middle to Lower Silurian origin to the south. Upper Silurian sandstones and scattered caps of Tertiary volcanics are also present. Middle Devonian granidiorite is localized near the junction of the Woori Yallock and Cockatoo Creeks (Geographical Society of Victoria 1977, 1981). The Macclesfield Creek catchment is more elevated than the Woori Yallock or Cockatoo Creek and the soils are indicative of leached duplex profiles derived from older (Devonian and Silurian rather than Quaternary) sediments. The floodplains of the creek system are areas of generally minor topographic variation (natural and otherwise) with the elevation ranging from 60 to 80 m above sea level.

Soils

At higher altitudes in the Upper Yarra Valley, soils are generally brown, friable, and gradational. At lower altitudes friable reddish and yellowish gradational soils dominate, with some acidic duplex soils in the lower rainfall areas in the west, and shallow stony soils on the steep slopes. Loams, dark clays, and yellow duplex soils dominate the river plains (LCC 1973; Rowan 1988).

Small areas of friable brown gradational soils are scattered throughout the Dandenong Ranges. Friable reddish gradational soils are more widespread, particularly on outcrops of basalt and dacite extending east to Gembrook, and have been largely cleared for agriculture. Shallow stony soils cover the steep slopes. In the lower-rainfall areas, acidic duplex soils, yellowish gradational soils and sodic duplex soils are all common (LCC 1973; Rowan 1988).

The floodplain of the Woori Yallock Creek lies on a mosaic of poorly and relatively well drained soils of alluvial origin. The soils vary from brown silty clays at the surface (0-5 cm) to clay loams at depth (50-100 cm). Soils along the Cockatoo Creek range from grey to brown silty clay loams (0-5 cm) to sandy clay loams (50-100 cm) of colluvial or alluvial origin. Sites are seasonally waterlogged and dry over the summer months. Pale grey silty clays are found throughout the soil profile (0-100 cm) along the floodplain of the Macclesfield Creek. A detailed discussion of the physical and chemical properties of soils within the YNCR is given by Kasel (1999).

Land Use

The human population within the Shire of Yarra Ranges has increased five-fold over the past 50 years with similar increases in the number of dwellings and a concomitant decrease in the number of rural holdings (Table 3).

Public land accounts for approximately 73% of the Shire of Yarra Ranges and includes most of the water supply catchments (providing 75% of Melbourne's water supply) and forested areas close to Melbourne. The bulk of publicly owned land is located within the Upper Yarra Ranges. Private land used for rural activities comprises approximately 24% of the total area within the Shire of Yarra Ranges

Table 3. Historical changes in land use within the Shire of Yarra Ranges.

Year	*1947*	*1967*	*1993*
Population	29 707[a]	55 530[a]	148 927[b]
Year	*1966*	*1976*	*1991*
Number of dwellings	18 588[c]	30 680[d]	49 583[d]
Year	*1959*	*1977*	*1993*
Number of rural holdings	1 981[e]	965[a]	477[f]
Total area of rural holdings (ha)	81 745[e]	49 530[a]	26 033[f]
Year	*1959*	*1977*	*1994*
Number of beef cattle	12 682[e]	39 905[a]	25 384[f]
Number of pigs	5 865[e]	11 527[a]	13 395[g]
Number of milk cattle	18 771[e]	9 796[a]	2 530[g]
Number of sheep	50 725[e]	10 067[a]	1 506[g]
Year	*1977*	*1990*	*1996*
Grape production (ha)	75[h]	415[i]	1 300

[a] Williams (1979); [b] Christoff and Wishart (1994); [c] CBCS (1966); [d] ABS (1991); [e] CBCS (1960); [f] ABS (1994); [g] ABS (1995); [h] Phillips *et al.* (1989); [i] Business East (1997).

and urban development accounts for a further 3% (Christoff and Wishart 1994).

The wide range of rural activities within the Shire of Yarra Ranges reflects the region's climate, soil fertility, proximity to Melbourne and historical development of farming. Agricultural and horticultural activities are discussed further as they represent the most common forms of land use in areas directly adjacent to the YNCR.

Agriculture

Some 9%, or 25 000 ha of the Shire of Yarra Ranges' total area is currently devoted to agricultural land use (ABS 1994). This represents approximately one third of the area of private land in the entire shire. More than half of this land (13 740 ha, including 2 460 ha of crops and 6 480 ha of pasture) is found near Lilydale (Christoff and Wishart 1994).

Pasture-based industries (dairy cattle, beef cattle, sheep and horses) dominate agricultural land use and dairy farming has been the most intensive and profitable of these uses. Dairying is in serious decline; between 1959 and 1994, the number of milking cows fell by 90% (Table 3). Beef cattle production is now the dominant livestock industry in the Shire of Yarra Ranges (Table 3) and has been stable during the last ten years (Christoff and Wishart 1994). Sheep farming for both wool and meat is a minor and declining activity (Table 3) while equine industries (especially breeding for recreational use, harness racing and thoroughbred racing) is a large but generally unquantified land use.

Horticulture

Some 2 000 ha within the Shire of Yarra Ranges is devoted to horticultural activity. The major horticultural crops are nursery plants, flowers, vegetables, fruit orchards, berry fruits and vineyards.

Vegetable production is a significant but again a declining land use in the Shire of Yarra Ranges. Major vegetable growing areas are Silvan, Wandin, Toolangi, Coldstream and Hoddles Creek. Approximately 520 ha of vegetables are grown in the Shire. The largest crops are carrots (almost 300 ha), brussell sprouts, cabbages, potatoes and beans (Christoff and Wishart 1994).

Over the past few years fruit production has remained stable. Crops include strawberries, apples, cherries and other stone fruits such as peaches and nectarines. The wine industry is expanding and the total area of vineyards increased from 75 ha in 1977, to over 1 300 ha by 1996 (Table 3).

Land use surrounding the Yellingbo State Conservation Reserve

Land uses directly adjacent to the YNCR boundary include intensive horticulture, cattle grazing and native forest. The intensive horticulture is in the form of a 'market garden' on the eastern bank of the Cockatoo Creek at the northern end of the YNCR. The market garden is approximately 14 ha in area and the major crops grown include broccoli, cauliflower and spinach.

The general changes in land use within the Shire of Yarra Ranges are reflected in changes in land use in areas bordering the

Table 4. Historical changes in land use surrounding the YNCR (based on the length (m) of each activity with the boundary[a] of the YNCR).

Year	Surrounding land use	Length of boundary with the YNCR					
		Cockatoo Ck		Woori Yallock Ck		Total	
		(m)	(%)	(m)	(%)	(m)	(%)
1946	Forest	8 382	39	7 308	61	15 690	47
	Pasture	13 224	61	4 592	39	17 816	53
	Horticulture	0	0	0	0	0	0
1968	Forest	4 717	22	3 422	29	8 136	24
	Pasture	16 892	78	8 478	71	25 370	76
	Horticulture	0	0	0	0	0	0
1988	Forest	1 504	7	2 878	24	4 382	13
	Pasture	18 836	87	9 022	76	27 858	83
	Horticulture	1 266	6	0	0	1 266	4
1998	Forest	3 357	15	2 878	24	6 235	18
	Pasture	16 983	79	9 022	76	26 005	78
	Horticulture	1 266	6	0	0	1 266	4
Total boundary lengths		21 606		11 900		33 506	

[a] Changes in land use surrounding the YNCR were calculated with the use of the following aerial photographs: 1998 colour, 1:16 000; 1988 colour, 1:10 000; 1969 b/w 1:10 000; and 1946 b/w 1:20 0000. The length of the boundary of the YNCR was kept constant throughout the analysis and was based on the boundary as it stood in 1995 (the perimeter of the YNCR in 1995 was superimposed on the corresponding area (images) for 1998, 1988, 1969 and 1946; the actual length of the perimeter changed over this time period as land was purchased and added to the YNCR).

YNCR. There has been a marked decrease in the area of native forest and a corresponding increase in pasture based activities and some intensive horticulture. For example, in 1946, native forest bordered about 16 km of the YNCR but only 4 km in 1988 (Table 4). Conversely the area of pasture bordering the YNCR increased from 18 km in 1946 to 28 km by 1988, with a further 1 km allocated to horticulture (Table 4).

With no further land clearing between 1988 and 1998, land uses surrounding the YNCR have remained fairly constant. Whilst keeping in mind the immature state of revegetated areas, land purchases and revegetation since 1988 have increased the 'forested' area surrounding the YNCR. For example, purchase and revegetation of 'Logan's land' (which was predominantly cleared, see Fig. 2) has increased the amount of forested area bordering the YNCR by 1 853 m (Table 4). Further revegetation and land purchases will increase this figure.

Acknowledgements

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David Ashton, OAM

Dr. David Ashton was awarded a medal of the Order of Australia in the recent Queen's Birthday Honours. He is an eminent botanist known to many Field Naturalists, and has contributed enormously to the understanding and appreciation of Victorian ecology. He studied at Cambridge with Dr. Alex Watt as supervisor and continued for an additional year with a Nuffield grant. In recognition of his astounding record of 50 years' research in the 'Big Ash' (*Eucalyptus regnans*) of Victorian mountain forests, Parks Victoria prepared and erected a beautiful bronze plaque at the Toorourong Reservoir. David has a rare ability of evaluating the forest as a whole, but still including all its detailed living processes from which the reader can visualise the living forest. David's research covers many other areas of Victorian forest such as the Brisbane Ranges, the Bogong High Plains, East Gippsland, Macquarie Island, Pelican Island in Western Port Bay, and overseas in Chile. His research extends from mycorrhizae to lyrebirds.

Some years ago David was made a Fellow of the Royal Society, and he recently received the Kookaburra award by Parks Victoria and a medal from the Ecological Society of Australia. The Department of Natural Resources and Environment has just named a biodiversity award after him. David has just completed an article on the history of the McCoy Society for *The Victorian Naturalist*.

Quiet, unassuming, friendly, and with a wicked sense of humour, David is also a talented artist. Congratulations, David, from the Field Naturalists Club of Victoria.

Gretna Weste
605 Park Road,
Park Orchards, Victoria 3114.

One Hundred Years Ago

King Island. -In the agricultural columns of the *Australasian*, of 27th July, "Bruni" writes that King Island, hitherto regarded as useless has, owing to the spread of an introduced plant, become valuable for dairy farming. When the members of the Field Naturalists' Club of Victoria held their first extended "camp-out" there, in 1887 (*Victorian Naturalist*, iv., p. 129), the country was reported as being sandy, sterile, and unsuitable for grazing, but it seems that since that time some seeds of a clover-like plant, *Melilotus officinalis*, were washed ashore from a wreck on the southern coast, and, contrary to the usual custom of introduced plants, has transformed the barren wastes into splendid pasture. The island now supports a population of about 250, and boasts a general store with post-office, while a creamery is talked of, but no school, church, or hotel has yet been established. The official requirements of the island are supplied by a police trooper. In the following issue of the *Australasian*, Mr. Frank Madden, M.L.A., writes warning farmers in Victoria against trying the Melilot as a pasture plant, as it is nothing more than a useless weed. It is, however, according to Baron von Mueller, "Select Extra-Tropical Plants," a valuable honey-yielding plant.

From *The Victorian Naturalist* Vol. **XVIII**, 1901.

W. Rodger Elliot, AM

Rodger Elliot and his wife Gwen Elliot were each recenty appointed as a Member in the General Division of the Order of Australia (AM) 'for service to the horticulture of native plants, particularly through the Society for Growing Australian Plants'.

Rodger was a member of the FNCV in the 1970s and early 1980s and rejoined Club in 1995, when he was awarded the Australian Natural History Medallion. He is currently a member of the Board of the Royal Botanic Gardens, an Honorary Life Member of the Australian Plants Society, a member of the Dandenong Ranges Garden Trust, and Deputy Chair of the Advisory Committee of the Maud Gibson Trust. He is a recipient of the Australian Institute of Horticulture's Award for Excellence and the Gold Veitch Memorial Medal.

Rodger is no doubt well-known to many members as a lecturer, broadcaster and author. He was a contributor to Your Garden magazine for over 20 years, has published plant field guides, botanical booklets and a number of gardening books. His major work-in-progress, co-authored with David L. Jones, is the 'Encyclopedia of Australian Plants Suitable for Cultivation'. This unique series, when completed, will cover the flora of the entire continent.

Gwen Elliot has been invaluable in all of Rodger's endeavours, which are listed in detail in an article by Sheila Houghton in *The Victorian Naturalist* **112** (5), 1995, pp. 188-189.

Congratulations Rodger and Gwen from the Field Naturalists Club of Victoria.

Rodger and Gwen Elliot.

The Victorian Field Naturalists Clubs Association

Annual Camp

Labour Day Weekend – Friday 8 to Monday 11 March 2002

The 2002 annual camp and meeting of The Victorian Field Naturalists Clubs Association will take place at Campaspe Downs Country Resort, 7 km SW of Kyneton, Victoria over the Labour Day weekend. As the Field Naturalists Club of Victoria is organising the event, we are hoping for the support of our members through their attendance and as volunteers for various tasks before and during the campout. Mark this date in your diary and come and enjoy guided excursions and walks through Victoria's Box and Ironbark forest remnants and surrounding areas. Learn about the plants, birds, mammals, invertebrates, fungi, geology and much, much more with field naturalist colleagues from around the State.

Guest speakers during the weekend are Dr Julian Hollis on volcanic activity in Victoria with emphasis on the Newer Volcanics, Stuart Dashper on Box-Iron Forests and Marcus Ward on Logging in Wombat State Forest.

If you would like information and a booking form, please write to Dorothy Mahler, Secretary, VFNCA Camp Weekend Organising Committee, 1 Astley Street, Montmorency 3094 and enclose a business-sized (approximately 22 × 10 cm) stamped, self-addressed envelope. A deposit of $30 is required by 19 November, 2001.

Nature Photography

by Ken Griffiths

Publisher: *University of New South Wales Press, 1999. 148 pp., colour illustrations. ISBN 0868406724. RRP $29.95.*

As a keen amateur photographer I tackled this book with some enthusiasm. I was not disappointed. Nor was John (obsessive videographer and long-suffering husband) as we both found this book informative, interesting, detailed and loaded with plenty of advice and examples of what to do and not to do when photographing nature.

The book is divided into two sections; Part 1, Equipment and Accessories, delves into the camera and the main format types of SLR, rangefinder, medium and large format and digital. But the book is about SLR photography and discusses camera features, lenses, flash, light meters, film, accessories, equipment care and maintenance, even what to look for when buying used equipment.

Photos are used as examples in how to use equipment, e.g. lenses illustrated with a collection of landscapes taken with a wide-angle lens and wider apertures. All pictures are captioned with notes describing the photo, type of lens used and aperture, shutter speed and type of film. Telephoto and macro, lens and flash features are all presented in easily-digested form and accompanying photos add detail to the text, illustrating, for example, types of flash equipment available and when to use each one.

Throughout the book key words are lightly highlighted in the text. A quick referral to the index of cross-referenced topics will lead to the page number where the highlighted topic is dealt with in detail.

Part 2 deals with 'Photographing Natural Subjects' under the headings of Natural Light; Macro and Close-up Photography; Picture Faults and Technical Problems; Where to Practice your Techniques; Plants and Animals Exposed; What to Wear and Carry; and Ethics when Photographing Wildlife.

I found Part 2 particularly useful, and armed with all the knowledge acquired in Part 1 applied some of the tips during our recent trip into Western Australia. Tips for photographing in brightly lit situations like white sand so as not to under-expose (Eyre Telegraph Station), taking photos of back lit subjects (Marble Gums and their white trunks are illuminated by back lighting in the Great Victoria Desert), using macro lenses (the detail of an Ooldea Mallee in flower in the Great Victoria Desert or a Rhinoceros Beetle on the attack on the road between Rawlinna and Cocklebiddy) are all covered within.

The section 'Plants and Animals Exposed' is a handy guide with advice on photographing all creatures great and small from invertebrates to landscapes and includes useful techniques, recommended lenses for each subject, when and how to improve your photo with the use of flash, when to use fast or slow shutter speed and open or closed aperture.

The book closes with some useful tips and a list of essential items required for a day's filming and a final emphasis on the three Ps of nature photography – practice, patience and perseverance. So it's back out to the bush for me, my camera and lenses in a purpose designed backpack and a healthy dose of the 3 Ps.

This book can be used by beginning SLR photographers who will learn much from the advice and detail presented here. Experienced photographers will also find it useful to extend their knowledge and capability in nature photography.

Anne Morton
10 Rupicola Court,
Rowville, Victoria 3178.

Wildflowers of Victoria

by Margaret G. Corrick and Bruce A. Fuhrer

Publisher: *Bloomings Books. 256 pp., 840 colour plates. RRP $59.95*

This terrific book illustrates 840 native flowering shrubs and herbs of Victoria, including 50 species endemic to Victoria. The plants are presented alphabetically by family, and a brief description of the distinguishing characteristics of each family precedes the individual species description. A wide array of flowers is included from many different habitats. For example, in the Daisy family, the Asteraceae, there are 128 photographs including *Microseris* sp. 2, which is common in alpine herbfields, *Leucochrysum albicans* subsp., *Alpinum* var. *tricolor*, currently known only from road verges, Water Buttons *Cotula coronopifolia*, widespread in damp areas and Sticky Cassinia, *Cassinia uncata*, which occurs mostly in western mallee and dry forest although a distinctive form occurs on shallow, rocky ground in the alps and subalps north of Licola. This family also includes the strange and bizarre such as Ground Heads *Chthonocephalus pseudevas* and Woolly Heads *Myriocephalus rhizocephalus*.

The species descriptions include the author, the common name where available, distribution and a few habitat notes. Included are measurements of leaves, fruits and flowers, to aid identification, along with plant height. The distribution information is provided according to the natural regions of Victoria, and these are illustrated on a map taken from The Flora of Australia (1994-1999). The introduction includes a brief description of the natural regions of Victoria, with reference to where they are situated within the state. A useful addition, however, would be the inclusion of flowering dates, such information being particularly valuable for people seeking rarely seen flowering plants such as Silvery Emu-Bush *Eremophila scoparia* or Fairy Lanterns *Thismia rodwayi*.

A glossary is provided and includes detailed descriptions of many technical terms, making the species summaries easier to understand.

'Wildflowers of Victoria' has such an extensive coverage of flowering shrubs and herbs of Victoria that it makes an ideal companion to Leon Costerman's 'Trees and Shrubs of South Eastern Australia'. Costerman's book includes coverage of shrubs which are generally taller than one metre, but a slight overlap does occur with a few species: Corrick and Fuhrer have included some small acacias, and a number of trees that display a shrubby growth form, such as Prickly Bottlebrush *Callistemon brachyandrus* described as a 'shrub or small tree 2-3 metres high' and Muttonwood *Rapanea howittiana* 'a small tree to 15 metres high'.

This book is packed full with beautiful colour photographs of the kind of exceptional standard we have come to expect of Bruce Fuhrer's work, along with simply written, easy to read text. Overall, it is a very readable and informative, beautifully illustrated book. Many species occur in other states as well so this book is ideal not only for Victorians but also for those identifying plants in similar habitats within neighbouring states.

Bernadette Sinclair
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For assistance with the preparation of this issue, thanks to Karen Dobson (label printing), Dorothy Mahler (administrative assistance) and Michael McBain (web page).

The Field Naturalists Club of Victoria Inc.

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Established 1880

In which is incorporated the Microscopical Society of Victoria

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McCoy Special Issue Part One

F.N.C.V.

Published by The Field Naturalists Club of Victoria *since 1884*

Foreword

Doug McCann[1]

This special two-part issue of *The Victorian Naturalist* has been produced in honour of the life and work of the nineteenth century Irish-Australian naturalist Sir Frederick McCoy. He died just over 100 years ago, on 13 May 1899, at about 77 years of age (his exact birth date remains uncertain). McCoy was the first President of The Field Naturalists Club of Victoria (1880-1883) and later, along with his renowned colleague Ferdinand von Mueller, was made a patron of the Club (1889). Although he was not directly involved in regular meetings and field excursions, the Club gained prestige and direction from his stewardship and he provided a useful link between the Club's activities and that of the Melbourne Museum of which he was first Director.

At the time of his death he was arguably Australia's most distinguished scientist. In an obituary in *The Geological Magazine*, the editor Henry Woodward stated that 'Professor McCoy was the acknowledged chief of the scientific world of Australasia' yet today he is little known outside the specialised areas of palaeontology and the history of science.

McCoy made significant contributions to taxonomic and stratigraphical palaeontology in Ireland and England, and to palaeontology and zoology in Australia. He was the first to confirm that Australian stratigraphy correlated with that in the northern hemisphere and hence to demonstrate that the geological column was a global phenomenon. He was foundation Professor of Natural Science at the University of Melbourne and concurrently Government Palaeontologist for the Geological Survey of Victoria and Director of the National Museum of Victoria, where he built up one of the finest natural history collections outside Europe and North America.

Why then is McCoy so little appreciated? The reasons are complex and varied. McCoy was, and remains, a somewhat controversial and contradictory figure. As well as making many worthy contributions to science he was also involved in some acrimonious and long-running scientific disputes, and in some of these he fared rather badly. Authors in this issue explore aspects of some of these debates. In a sense McCoy has had to endure a 'bad press' in which his negative qualities have been emphasised (i.e., one historian referred to him as that 'bad tempered redheaded Irishman') and his more positive contributions have frequently been ignored or forgotten.

The breadth, and often the depth, of his work, however, were considerable. He was very much a product of the mid nineteenth century, when natural history enjoyed widespread popularity and standing. Taxonomy and classification were highly esteemed activities, in keeping with the then prevalent philosophy of Natural Theology. It was an era of geographical exploration and extensive collecting. There was much being discovered that was new to science and a need for it to be classified and described. McCoy was an accomplished naturalist and a very diligent taxonomic palaeontologist. Even in his day palaeontologists were beginning to specialise but the scope of McCoy's work was remarkable; he covered virtually the whole of invertebrate palaeontology as well as being competent in vertebrate palaeontology and zoology. He was also well versed in geology, botany, mineralogy, chemistry, mining technology and many of the arts.

A reassessment of McCoy's life and work has been long overdue. The current collection of papers provides a variety of viewpoints and some general as well as some in-depth studies of many aspects of his life and work. This two-part issue of *The Victorian Naturalist* offers the first exhaustive critical study of McCoy and will provide an obligatory starting point for any future work on McCoy's scientific contributions and of his life and times.

Many people have contributed towards the success of this project, in particular, the individual authors and the dedicated and patient work of the editors Merilyn Grey, Anne Morton and Alistair Evans. Special thanks are due to Professor Neil Archbold for proposing and nurturing this project from the very beginning, and for his written contributions and generous material support. The end result of the combined work of all the contributors is a landmark in documenting, analysing and understanding a pioneering period in the history of natural science in the Colony of Victoria and of the contributions of Sir Frederick McCoy, an eminent nineteenth century Victorian naturalist.

[1] School of Ecology and Environment, Deakin University, Rusden Campus, Clayton, Victoria 3168.

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Front cover: Lithograph of Frederick McCoy by Frederick Schoenfeldt; from a series entitled 'Notable Men of the time'. Published by Hamel and Co., c. 1859. Signed by Frederick McCoy. La Trobe Picture Collection, State Library of Victoria.
Back cover: Frederick McCoy, c. early 1870s. UMA/I/1242 University of Melbourne Archives.

Timeline: Frederick McCoy (1823-1899)

Doug McCann

c. 1823	Born in Dublin (exact year of birth uncertain). Second son of Dr Simon McCoy, physician and professor of materia medica, Queen's College, Galway.
1838	First paper published in *Magazine of Natural History*: **Remarks on Mr. Eyton's arrangement of the Gulls**.
1839	Arranged the collections of the Museum of the Geological Society of Dublin and became a member of that Society. (The Catalogue of the Museum published 1841 – McCoy's first publication on fossils.)
c. 1840	Engaged by Sir Richard Griffith to determine fossils collected by Griffith and the staff of the Boundary Survey for a Geological Map of Ireland.
1841	Named and catalogued for sale shells and fossils of the Henry Sirr Collection. Curated collections of the Royal Dublin Society and the Geological Society of Dublin. First met Adam Sedgwick.
1843	Married Anna Marie Harrison in Dublin.
1844	Publication of **Synopsis of the Carboniferous Limestone Fossils of Ireland** (based on his work for Sir Richard Griffith).
1845	Geological Survey of Ireland established. McCoy hired as first field staff member. Surveyed and completed maps. Resigned September 1846.
1846	Publication of **Synopsis of the Silurian Fossils of Ireland** (based on his work for Sir Richard Griffith). In November invited by Adam Sedgwick to arrange the fossil collection of the Woodwardian Museum at Cambridge (worked on this project 1846-1854).
1847	Publication of **On the fossil botany and zoology of the rocks associated with the coal of Australia** in *Annals and Magazine of Natural History* (based on examination of fossils collected by Rev. W.B. Clarke and sent to Sedgwick).
1849	Appointed Professor of Mineralogy and Geology at Queen's College, Belfast. Continued work with Sedgwick during vacations.
1852	Elected Fellow of the Geological Society of London.
1854	Appointed Professor of Natural Science at the University of Melbourne (lifelong tenure). Publication of **Contributions to British Palaeontology** (reprint of 28 papers from *Annals and Magazine of Natural History*). Arrived in Victoria December 1854.
1855	Publication of **Synopsis of the British Palaeozoic Rocks and Fossils** (McCoy's major work). University of Melbourne officially opened. McCoy lectured in a wide range of subjects including chemistry, botany, mineralogy, comparative anatomy, systematic zoology, geology and palaeontology.

1856	Appointed Palaeontologist to the Geological Survey of Victoria. Moved National Museum of Victoria collection to University of Melbourne. 'System Garden' laid out in north-west corner of university grounds. Chairman of Royal Commission on the Victorian Goldfields.
1858	Formally appointed Director of the National Museum. Appointed to Victorian Board of Science.
1861	Vice-President of the Royal Society of Victoria. Acclimatisation Society established – McCoy and Frederick von Mueller Vice-Presidents. Publication of **Note on the ancient and recent natural history of Victoria** in Catalogue of the Victorian Exhibition – the first general account of palaeontology and zoology in Victoria.
1864	President of the Royal Society of Victoria.
1867	Publication of **On the recent zoology and palaeontology of Victoria** in *Annals and Magazine of Natural History* (included the first detailed list of Victorian birds).
1869	Public lecture **The order of creation**. Began publication of a series of popular articles on Victorian and Australian natural history in the *Australasian* under the pseudonym 'Microzoon' (from 1869-1871).
1870	Public lecture **The plan of creation**. Vice-President of the Royal Society of Victoria.
1874	First part of **Prodromus of the Palaeontology of Victoria** published (work on it actually started in 1858; published serially; publication ceased with seventh decade 1882).
1878	Publication of **Prodromus of the Zoology of Victoria** (in twenty parts with 200 coloured plates; published serially 1878-1890).
1879	Awarded Murchison Medal from Geological Society of London.
1880	Elected Fellow of the Royal Society of London. Invited to be First President of the Field Naturalists Club of Victoria (President for three years 1880-1883).
1880s and 1890s	Many honours conferred upon him including a knighthood (KCMG) in 1891. Now regarded by many as Australasia's most distinguished scientist. Honourary member of many British and foreign learned societies. Royal honours from Italy and Austria. Received D.Sc. from Cambridge 1886 (one of the first granted). McCoy's health deteriorated in 1890s – protracted bouts of bronchial illness. Wife died 1886, son died 1887, daughter died 1891.
1899	Died 13 May. Buried in the Brighton Cemetery, Melbourne.

Geological Time Scale

(a)

Tertiary
Secondary
Transition
Primitive, or Primary

(b)

ERA	PERIOD	EPOCH	Mill yrs ago	CHARACTERISTIC LIFE
Cenozoic	Quaternary	Recent	<10000 yrs	Man
		Pleistocene	1.8	
		Pliocene	5	Great variety of mammals
	Tertiary	Miocene	24	Flowering plants. Ancestral dogs and bears
		Oligocene	34	Ancestral pigs and apes
		Eocene	55	Ancestral horses, cattle, elephants
		Palaeocene	65	
Mesozoic	Cretaceous		141	Extinction of dinosaurs and ammonities. Mammals and flowering plants slowly appear
	Jurassic		205	Dinosaures and ammonites abundant. Birds and mammals appear
	Triassic		251	Flying reptiles and dinosaurs appear. First modern corals
Palaeozoic	Permian		298	Rise of reptiles and amphibians Conifers and beetles
	Carboniferous		354	Coal forests (North Hem.) First reptiles and winged insects
	Devonian		410	First amphibians and ammonities. Earliest trees and spiders. Rise of fishes
	Silurian		434	First spore-bearing land plants Earliest known coral reefs
	Ordovician		490	First fish-like vertebrates. Trilobites and grapolites abundant
	Cambrian		545	Abundant fossils first appeart (trilobites, graptolites, brachiopods, molluscs, crinoids, radiolaria and foraminifera)
Proterozoic			2500	Scanty remains of primitive invertebrates: sponges, worms algae, bacteria
Archaean			4600	Rare algae and bacteria back to at least 3400 million years

Geological strata classifications: (a) classification used in Britain in the 1820s (Secord, J.A. (1986). 'Controversy in Victorian Geology: The Cambrian-Silurian Dispute'. Princeton University Press: Princeton.) ; (b) current Australian classification (after Australian Geological Survey Organisation 1996).

Sir Frederick McCoy FRS – an Overview

Malcolm Carkeek[1]

When Frederick McCoy arrived in Melbourne late in 1854 to take up the foundation chair of Natural Science in the University of Melbourne he was plain Mr McCoy, without tertiary qualifications or honours, but already a Fellow of the Geological Society, London. At his death in 1899 he was Professor Sir Frederick McCoy, Knight Commander of St Michael and St George - the first professor of an Australian university to be knighted; Fellow of the Royal Society; holder of the Geological Society's Murchison Medal; Doctor of Science *honoris causa* (Cambridge) – the first to receive this newly created honour; Honorary Member of the Cambridge Philosophical Society – limited to 30 British citizens, the cream of the Empire's scientists; Chevalier of the Royal Order of the Crown of Italy; recipient of the Emperor of Austria's Great Gold Medal for Arts and Sciences, etc, etc, etc. He still held his professorship and had been foundation Director of the National Museum of Victoria since 1857. The recognition and the honours were the result of four decades of relentless drive by McCoy to create a museum that fulfilled the public role he perceived for it. In the late nineteenth century the National Museum of Victoria was recognised internationally as one of the world's great natural history museums. This status was achieved almost entirely by the unremitting determination, vision and passion of one man, against an array of opposing forces that would have eventually ground down and crushed a man not so possessed. As with many who make their mark, McCoy was a man of great enabling talents, dogged by a number of disabling characteristics.

In 1853, the newly established University of Melbourne was seeking to fill four chairs. One of a long and somewhat demanding list of criteria provided by the university to the selection panel in London was that the professorial candidates had to be graduates of one of the major universities of Great Britain. From a field of over ninety applicants, the panel, headed by Sir John Herschel the noted astronomer, chose three graduates well-recognised in their discipline, and Frederick McCoy who, although he did not satisfy the degree criterion, was so outstanding in his field that he was selected notwithstanding. McCoy was not without academic recognition; he was at the time Professor of Geology and Mineralogy in Queen's College, Belfast and was recognised in Great Britain as one of its leading palaeontologists. How he reached this position by his early thirties is explained in Tom Darragh's meticulous contribution. Shortly before leaving for Australia, McCoy had published the definitive work on the Palaeozoic rocks and fossils of Great Britain and was in the limelight in scientific circles for providing the palaeontological evidence that was instrumental in resolving the great Silurian/Cambrian controversy. This and McCoy's other contributions to stratigraphical palaeontology are covered in detail in Doug McCann's paper.

As amply demonstrated in Ian Wilkinson's paper, McCoy did not make his mark as one of the University's really great teachers, particularly in his later years. Considering everything else he was involved in, it is surprising that he ever got around to teaching at all. He was constantly at loggerheads with the Building Committee, mostly in regard to the National Museum; indeed one could add: the Chancellor, the Vice-Chancellor, the Registrar, the Professorial Board and anyone else who sought to thwart him in anything that he considered to be for the well-being or advancement of any enterprise for which he was responsible or closely involved.

McCoy was a convergent thinker, saw things in black and white, was obsessive about detail and was unable to appreciate that not everyone's thought processes are governed by logic, and hence he was often

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intolerant of other opinions. Basically, he was a fairly typical scientist. As Scott (1936) said of McCoy,

> His meticulousness was often trying to the University Council, and there was rarely a meeting of that body at which 'Letter from Professor McCoy' did not figure on the Agenda. Sometimes there were several letters from him, all pressing for something to be done.

McCoy would present a cogently argued case in support of some demonstrably valuable and justifiable plan, only to be knocked back with 'we can't afford it'. To a man of science this was no answer at all and he would persist, sometimes for years, until he got what he wanted.

Arguably, McCoy's major achievement for the University was the systematic Botanic Garden; and this is perhaps a good example of his relationship and interaction with others in the University community. From a faltering start in 1856, the garden grew under McCoy's watchful and caring eye through the sixties, the latter part of which were probably the peak of the garden's development and use, with two gardeners, heated glasshouses and all totally under the control of its founder. The seventies brought much disputation about staff numbers, their salaries and funds for specimens and running expenses. Money was always in short supply and the garden suffered in consequence. McCoy's constant importuning on behalf of his beloved garden met with little positive response; rather, he was more likely to be told by the Building Committee 'The wants of the general grounds at present are more urgent than is the necessity for propagating exotic plants which require artificial heat approaching that of the tropics!'. McCoy cuttingly referred to the former as 'pleasure gardens'. Finally, in 1880, the Council set up a committee to investigate the condition and management of the Botanic Garden. This committee recommended that the garden be removed from the control of McCoy and handed over to the Head Gardener – he of the 'pleasure gardens'. McCoy came out fighting, and replied that at the time of the inspection in Spring, the weeds were at their height and the one gardener was temporarily otherwise occupied; plants had died over the last twenty years and no money had been forthcoming to replace them, and at least the labels gave some indication as to what might have been there, had the garden been properly supported. Despite a strongly supported student petition to the Council calling on it to not remove McCoy from his curatorial role, control of the Botanic Garden passed to the Head Gardener, a man with whom McCoy had often clashed. The garden was allowed to deteriorate and its value as a teaching adjunct greatly diminished until it was eventually subsumed in the general gardens. Fighting against parsimony and disinterest, McCoy held the garden together for nearly 25 years, but lost in the end. Gwen Pascoe's paper describes the establishment and layout of the garden, and expands on McCoy's problems in managing it.

It was the Surveyor General, Captain Andrew Clarke RE, who first recognised the value, and was the driving force behind the establishment, of a public museum for the education and instruction of Victorians. Clarke had been Secretary to Governor Denison in Tasmania when a public museum was set up there under the aegis of the Royal Society of Van Dieman's Land. Clarke took up his duties in Victoria in May 1853, and in the following September the Legislative Council voted 36 to 7 that the Estimates of the following year include a sum for the establishment of a Museum of Natural History. The 1854 Budget included a sum of £2,000 towards the establishment of such a museum, and a similar sum for a Museum of Economic Geology. Both were placed under the control of Clarke, and he found two rooms above the Assay Office to house them. The collection grew rapidly under the curatorship of the Government Zoologist, William Blandowski. But, between mid-1855 and the end of 1856, the whole collection was transferred to the University and placed in the care of Professor McCoy. At the time there was much opposition, much confusion and not a little dissembling regarding this operation. Some source material from the period has been influential in the painting of an unfair image of McCoy in more recent times.

In *Redmond Barry*, Ann Galbally (1995), in referring to the movement of the national collection to the University, states, 'McCoy saw his chance, and in another example of Irish energy organised to "borrow" the collections for an exhibition at the University. They were never returned in his lifetime.' She later claims that Barry 'decided not to oppose McCoy's commandeering of the Museum of Natural History'. Ann Moyal (1986), a respected historian of Australian science, says of this event,

> ... at Melbourne University ... McCoy built up an impressive economic and mining museum which attracted great attention from the public. Fired by this success, and already negotiating with the governor of Victoria on the housing of the national collection, McCoy, in the summer of 1856, unceremoniously carried off the natural history collection, despite protests from the Philosophical Society.

She calls this 'an act of brigandage'. McCoy himself best answers these charges in a letter dated 28 June 1856 to Redmond Barry in his capacity as Chancellor of the University. It is a key document and worth quoting extensively.

> About a year ago His Excellency Sir Charles Hotham having determined to omit the Colonial Natural History grants from the estimates and an announcement having appeared in the papers that the Survey Museum was to be broken up, I waited upon the authorities and having represented the advantages to the community of continuing the collections and ascertaining exactly what natural objects were to be found in the Colony. I suggested that the economic difficulties in the way (such as the necessity for building a separate museum, purchasing the large number of cases required, paying attendants, etc.) might be obviated by placing the collections in the charge of the University; where also the necessary scientific books and specimens of other countries for comparison would be at hand to facilitate the classification of the specimens, and where they could be safely deposited, arranged and be freely open to the public.
>
> The Colonial Secretary thereupon forwarded at His Excellency's desire the letter dated 10th July 1855 enclosing a memorandum, dated 29th June 1855, of my proposition and desiring the opinion of the Council of the University thereon.
>
> To this the Council replied by letter dated Sept. 15th, expressing their willingness to take charge of these collections, but a paragraph having been introduced to the effect that money should first be furnished to build a Museum for them, His Excellency was obliged to reply, by a letter dated Sept. 25, that he could not sanction the arrangement on such terms till the money was voted by the Legislature. Immediately however on the Council writing, by letter dated Oct. 2nd, that they would unconditionally accept the custody of the collection, His Excellency forwarded to them a letter of thanks, dated Oct. 16th and promising to communicate directly on the Surveyor General's return.
>
> Accordingly, on the arrival of the Surveyor General that officer came to the University to ascertain what means we had for carrying out the arrangement; and, having carefully inspected the rooms which we then had ready for temporary accommodation, and examined the plans and drawings of the Museum we then proposed to build, with the necessary fittings, glass cases etc. he expressed himself perfectly satisfied and **gave me a definite promise** that he would order the collections to be sent up at once.
>
> Finally, when another member of the Executive (the Honorable the Commissioner of Trade & Customs) asked the Legislative Council to agree to the vote for building the north side of the University he distinctly announced that the Colonial Natural History Collection **had been transferred to the University** and that this small vote would save the country the great expense of providing separate accommodation for them.
>
> The Botanical specimens have been partially delivered and the whole of the Geological collection made by Mr. Selwyn have arrived and are rapidly being classified and made useful at the Department ...

I have read each of the documents to which McCoy refers, and they all agree with what he says. This was not a brigand commandeering that to which he had no right, but rather the orderly transfer of the collection, as agreed and arranged between the Government and the Council of the University. When the transfer of the national collection from the Assay Office to the University was well under way, the death of Governor Hotham and the installation of a more sympathetic, if temporary, ear in the form of Major General Macarthur gave the Philosophical Institute the opportunity to perhaps reverse the decision with which it strongly disagreed. It petitioned the Acting Governor to relocate the national collection in the Public Library basement, prompting the Colonial Secretary to ask the University if it was prepared to continue to be responsible for the national collection and the Trustees of the Public Library if they were prepared to assume responsibility for it. On behalf of the University, the ubiquitous Redmond Barry replied, *Yes*; and on behalf of the Trustees, he replied, *No*. On hearing this, the Philosophical Institute organised a public protest meeting on 26 July 1856 - recall that McCoy's letter was dated 28 June. Not surprisingly, those who were moved to attend voted overwhelmingly to have the National Museum in the city. When the next shipment of specimens from the Assay Office to the University happened a few days later, the Philosophical Institute and the press had a field day accusing McCoy of all sorts of malfeasance. *The Argus* fulminated and *Melbourne Punch* lampooned him in cartoon and doggerel; and writers have been perpetuating this myth ever since.

The establishment of the museum in the University gave McCoy the opportunity to once again do what his previous activities showed he most enjoyed; building up and directing a natural history museum - and this he set about doing with considerable skill, zeal and tenacity. Soon some funds were forthcoming from the Government and additional space added to the University buildings to house the National Museum. Over the next six years McCoy avidly acquired specimens from both the collectings of the ongoing Geological Survey of Victoria and through overseas agents, but only 'those of the highest quality'. Anthea Fleming's paper on McCoy's correspondence with John Gould relating to the acquisition of bird collections for the museum clearly illustrates the problems McCoy had in financing acquisitions in general and the extent to which he was prepared to circumvent normal fiscal restraints to advance his beloved museum. McCoy soon ran out of display and storage space in the museum and again appealed to the Government, who after negotiations with the University Council built one half of a planned National Museum building within the University grounds. It was never to be completed. The development of the museum under McCoy's leadership is explored and detailed in Carolyn Rasmussen's paper.

The University had initially welcomed the housing of the national collection on its campus, albeit on a temporary basis, and the Council gave unanimous approval for its extension. By 1865 the University's attitude to hosting the National Museum had changed considerably; it saw this nestling as a rapidly growing cuckoo threatening its own fledgling museum. From time to time McCoy was required to list recent acquisitions of the University Museum. As the University was always running on a reduced budget, little money was made available to McCoy to purchase specimens, hence the collection grew slowly and mostly by donations. McCoy had a somewhat perverse sense of humour; on one occasion he reported, po-faced, that there had been few additions during the year, with the chief of these being:

- A bottle of slugs, supposed to have been vomited up by a man (donated by the Vice-Chancellor);
- A bottle of water from Tarrangower (also donated by the Vice-Chancellor);
- Three birds' nests and the beak of an albatross;
- A piece of wood from the Holy Land;
- A small crawfish from the Yarra;
- A small box of insects;
- Three bones (unidentified).

In 1869 the government placed the Public Library, the Museums and the National Gallery under the control of a board of trustees. McCoy, who had held his directorship of the Museum through his position of State Palaeontologist and was thus answerable only to the Chief Secretary, now had 15 'masters', including Redmond Barry who was the Board's first President. As well as a wig, Barry wore other hats: in regard to the National Museum he was positioned uneasily between being President of the Trustees vested with its control and Chancellor of the University.

He and McCoy were often in conflict over the Museum. In 1856, Barry the Chancellor was interested in acquiring the Museum for the University, while Barry the Museum Trustee wanted the available space in the Public Library building for an Art Gallery. As time went on and more space became available at the Public Library, Chancellor Barry, perhaps weary of his regular confrontations with McCoy, yielded to Trustee Barry and pressed for a relocation of the Museum. For reasons yet to be established, Barry, the mover and shaker, was not wholly successful. The Trustees wished to have the whole of the Museum moved to the Library site, but the Act incorporating the Library, Gallery and Museums specifically forbad the removal of the Natural History Museum from the University; so they appointed a Sectional Committee to control the operation of the Museum and its Director. The general attitude of the Trustees may be gauged from the fact that none on this committee had any background in science. The committee lost no time in putting its stamp on the Museum. Declaring its intention that the National Museum should be 'a collection illustrative of Zoology and Palaeontology' it ordered that the mineralogy collection and the mining and agricultural models that McCoy had so assiduously collected from Europe were to be removed to the new Science and Technology Museum, situated in the Public Library building, and under the control of another curator. McCoy fought vigorously but in vain, because the Government sanctioned the move. Ostensibly, the action was to relieve the overcrowding at the National Museum and make the models more readily available to the public, but the setting of the battle lines on who was master and who servant must have also played a part. In 1870, the Committee paid tribute in its first annual report to 'the zeal and perseverance of the learned Director, Professor McCoy.' In 1876, they observed pompously 'The general conduct of the Museum has during the year met with the approval of the Committee.'

As explained in Doug McCann's stratigraphy paper, McCoy was at home in the laboratory and the office rather than as a collector in the field, and it was there, as Director of the Museum and State Palaeontologist, that he made his major contribution. Many of the local specimens collected by the Geological Survey and amateur collectors were identified and named by McCoy – similar to the work he had done with the Woodwardian collection at Cambridge University. While his work ranged widely, the following papers highlight some of the areas in which he contributed significantly: John Seebeck and Robert Warneke, 'McCoy's Mammals'; Alan Yen *et al.*, '*Prodromus of Zoology*'; Philip Bock, 'Bryozoa'; Noel Schleiger, 'Graptolites'; Leigh Ahern, 'A Bite from the Past'; Neil Archbold, 'Brachiopods'; Mark Warne, 'Bairdia'; Adrian Hell, 'Ichthyosaur'; and Bernard Mace, '*Thylacoleo*'.

As you read the annual reports of the Museum Committee with their Appendix A – Director's Report, between the years 1870 and 1899, the profile of a resolutely determined man of indomitable spirit emerges. Year after year for 29 years McCoy reported that there was a desperate shortage of public and operational space in the museum that caused such overcrowding as to make viewing of the exhibits difficult, but the number of visitors continued to increase, as did the number of specimens received, prepared, identified, catalogued and arranged. Each year there was an ever-optimistic appeal for capital funds to complete the other half of the Museum building. This plea was invariably matched by that of the Committee, but they sought funds to relocate the Museum to an extended Public Library site. Finally, in 1876 the Government placed upon the vote for Public Works, £2,000 for '... additions to the National Museum.' The Committee decided 'that it is not desirable to expend any more money for this purpose on the University Grounds, but that a suitable building be erected on the site vested in the Trustees'. None of this money actually eventuated and over the next 20 years governments came and went; some voting funds for the Museum, but none carrying the work through. Even during the booming 1880s the Museum's operating funds were steadily eroded to a point where creditors and even staff were not being paid and the purchase of specimens from overseas was out of the question.

These were not happy times for McCoy. Quite apart from the difficulties with which he had to contend at the Museum, the death of his wife, son and daughter within five years of each other; mounting financial problems (mostly caused by paying for Museum acquisitions from his own pocket rather than lose an opportunity to gain some important specimen); and steadily deteriorating health, left him bruised and perhaps a little bowed. He wrote to Baron von Mueller in 1891:

> I am still so weak, & get my strength back so slowly that I am quite out of spirits and patience. Yesterday after my second lecture I was so exhausted that I had to go and lie down before I could go home. Each day however I am a little better & hope soon to be well enough to tackle my arrears of work and return thanks to all the Kind enquiries during my nearly three months mostly in bed. My medical attendant protests against my return to work and lecturing.

While this was a time of recovered amity, 30 years earlier McCoy and Mueller found themselves on opposite sides in a tussle between colonial and imperial science in the form of the Cranbourne Meteorites, the full story of which is given in Sara Maroske's paper.

It is easily forgotten that McCoy held down two full-time jobs throughout the 43 years from 1856 to his death at the age of 77, and served on numerous governmental advisory bodies during this period. He was an active member and office-holder of the Royal Society of Victoria, a regular contributor to local and international scientific journals, provided an anonymous contribution on natural history topics (see McCann, Microzoon) and maintained a busy correspondence with fellow practitioners around the world. At his death the museum contained over half a million specimens; and while a substantial number came as established collections, the majority were identified, catalogued and arranged by McCoy himself over the four decades the Museum was in his care.

If the Trustees, the University and the Government found McCoy to be a thorn in their collective side, the rest of the world was more generous in its recognition. Australia had a unique native flora and fauna that was attractive to museums around the world. McCoy traded far and wide, and through the national museums of many countries gained important contacts and an international reputation as a natural history scientist. Civil, academic and professional honours followed.

While McCoy is particularly known for his role at the Museum and the University, there were other organisations in which he was involved and/or recognised. In 1935, at the suggestion of the Vice-Chancellor of Melbourne University, a society for the study of field investigation and research was set up and named for McCoy, honouring the foundation professor of Natural Science. The society's 60+ year history is reviewed in David Ashton's paper 'The History of the McCoy Society'. It seems that McCoy's name carried some cachet. As Sheila Houghton reveals in her paper 'Frederick McCoy and the FNCV', McCoy, despite having been elected foundation President, limited his participation in the Club's activities over the three years he held the position to giving the Presidential Address at the annual Conversazione. He was somewhat more involved in the Acclimatisation Society of Victoria. In 1862, McCoy made a seminal address to the Society. In it he sounded a sober, cautionary note against a growing enthusiasm for attempting to bring fauna from all over the globe to be acclimatised. He stressed that only animals from regions of similar climate should be considered and condemned the importation of 'exotics'. On a lighter note he spoke of his own sadness at not being able to hear the song of European birds in an alien environment and he strongly promoted their import as an anodyne for homesickness. The good sense of the former has been ignored and the humanness of the latter has been ridiculed. Linden Gillbank's paper traces the history of the Zoological Society and the Acclimatisation Society and the degree to which McCoy contributed to them.

All of about a dozen articles I have read focus their condemnation of the Acclimatisation Society on McCoy and a knee-jerk reaction might be to believe that he was personally responsible for the introduction into Australia of everything from rabbits to cane-toads. When you carefully evaluate all this material you realise that McCoy was, in fact, a fairly inconsequential player in the whole imbroglio. One explanation of this apparent anomaly is that McCoy has been made a lightning rod for all the Jovian bolts that those blessed with 20/20 hindsight so enjoy casting. When you write about events that happened a century or more ago there is a limited amount of paper on which to draw. McCoy was a great one for producing paper; he corresponded widely, he was a member of all the learned societies in the colony, he wrote letters to the papers, he lectured on controversial subjects – that were then reported in the papers; he had an opinion on everything and was not afraid to express it – he provides much quotable material. This results in his appearing larger than life and to having a higher profile in a number of events and issues than he in fact deserves – and this applies just as much to his accredited successes as to his perceived failures. It has been said that he who never makes a decision or takes a position, never makes a mistake; the obvious corollary is that the more decisions and positions you take the higher your rate of mistakes is likely to be. McCoy was never loath to lay it on the line and consequently he made some really big blunders that, had they been acted on, would have had significant economic consequences for the colonies.

As everyone knows, in the early 1850s there was a gold rush in Victoria. But as quickly as they were discovered, the alluvial deposits were panned out and more sophisticated and deeper-seeking methods were required. In 1856 a Royal Commission was set up under the chairmanship of Professor McCoy to investigate the long-term potential of gold mining in Victoria. The resulting report was at once a disappointment and a puzzle to the mining fraternity. Whilst opposing him on the Carradoc beds, McCoy deferred to Murchison in the latter's contention that gold veins in quartz were at their richest nearest the surface and diminished with depth. As more and more reefs were traced down and down – some to a depth of half a mile at Bendigo and still yielding payable gold, McCoy became something of a laughing stock. Serle (1963) says, 'McCoy probably more than any man created or confirmed the Australian legend of the "impractical academic"'. While this is perhaps a little harsh, McCoy certainly did not cover himself in glory in this area, nor in his dispute with Rev. W.B. Clarke over the age of the NSW coalfields.

Clarke, another of Adam Sedgwick's students, might rightly be called the father of Australian geology. He was based in NSW and was the major influence in defining likely areas for coal exploration. While Roger Pierson clearly explains the whole controversy in his paper by presenting the geological and palaeontological evidence, the essentials are that McCoy and Clarke disputed the age of some of the coalfields in NSW, based on their fossil content. If McCoy were right, the potential for coal discoveries in NSW would be substantially lower than if Clarke were right, with the viability of a major economic resource at question. McCoy based and held his position on his examination of specimens that Clarke had sent to Cambridge while McCoy was working there. McCoy assessed them in terms of European geology, while Clarke was on the ground in Australia. Whilst the dispute raged for twenty years, McCoy made no attempt to travel up from Melbourne to Maitland to see for himself, despite repeated invitations and challenges by Clarke to do so. He certainly was an intractable reactionary!

Because McCoy did not wholeheartedly accept Darwin's theories of evolution he has been dismissively labelled a 'creationist'; a term that has pejorative connotations for many. It would be misleading to view him in this context. While ultimately deferring to a 'Divine Blueprint', he presented in two public lectures circa 1870 a carefully reasoned scientific position opposing Darwin, based on available geological and palaeontological evidence and firmly embedded in the prevailing scientific paradigm. He was not persuaded by a new and questionable hypothesis that challenged the perceived wisdom of Science, Society and Religion. Today, most would consider him wrong-headed. But his was not the wrong-headedness of dogmatic theism; rather McCoy was perhaps something of a deist. It was more a case of McCoy's science informing his religion, rather than his religion confounding his science. Darwin's theories are best observed at work in more recent times, geologically speaking. The fossil record today does not show a slow but steady transmutation from one species to another; and in McCoy's day much less was known, much less discovered. Indeed, today we still see large gaps in the fossil record; transition species are few and far between. Stephen Jay Gould (Eldredge and Gould 1972), a respected American palaeontologist, hypothesises the uneven fossil record in terms of 'punctuated equilibria' – long periods of genetic stability interrupted by brief flurries of major mutation. Echoes from McCoy's lectures sound curiously contemporary.

> ... The whole scheme of nature is not a continuous unbroken cord or chain of slight development, as the progressive development theory would require; but that at the point of change from every one of these subkingdoms to another you find a total change of plan - a totally new mode of construction for all the essential characteristics of the creature.

Barry Butcher's paper on McCoy and Darwinism looks at the issue in the social and religious context of the time and both generally and specifically – at McCoy's position in it. Wayne Gerdtz's paper on *Sarcophilus harrisii* provides an interesting insight into how McCoy's attitude to evolutionism impacted on the practice of his science.

Presently, not a great deal is known of McCoy's personal life. He was the second son of Simon Henry McCoy (c. 1795-1875) and Bridget (surname not known; c. 1799-1876). They had at least three children: a son of unknown name, Frederick and Agnes (c. 1826-1901). Simon was a prominent medical practitioner in Dublin, a Licentiate of the Royal College of Surgeons from 1828 and Professor of Materia Medica, Medical Jurisprudence and Toxicology in Queen's College, Galway, from 1849 (the same year in which his son Frederick became a professor in Queen's College, Belfast). McCoy was expected to follow in his father's professional footsteps but, after completing the theoretical work for his medical degree and being too young to practise, he pursued his passion for natural science, did not complete the requisite practical experience and thus was not admitted to the degree – see also Tom Darragh's paper. Medicine's loss was palaeontology's gain.

In 1842 McCoy married Anna Maria Harrison (c. 1819-1886), daughter of Thomas Harrison, Attorney, and Eliza Coonan. To Anna were born five children, three of whom died in infancy. Frederick Henry (1843-1887) graduated in Law from the University of Melbourne in 1868 and migrated to New Zealand where he set up practice in 1870 as a barrister and solicitor in the country town of Lawrence. He married Mary Ann Thompson (1852-1938) in 1870 and they had eight children. Emily Mary (1842-1891), unmarried, lived in the parental home all her life, probably housekeeping for her father after her mother's death.

The McCoys were members of what might be called the 'intellectual aristocracy' of Melbourne; McCoy was a member of the Melbourne Club and a Justice of the Peace, and one gets an occasional glimpse of their social life through the diary entries of their contemporaries. McCoy was born a Roman Catholic and was buried in Brighton Cemetery according to the rites of the Church of England. Whether this was a 'Via Damascus' conversion or a pragmatic update to his *curriculum vitae* in a Protestant England is unknown, but Rev. Sedgwick, a minister of the Church of England, and mentor of the young Frederick, somewhat dramatically averred in a letter supporting McCoy's application for the Melbourne University post that: '... McCoy was brought up a Papist but he was a good truth-loving Catholic, and never a Gadarean swine – He is now a conscientious member of the English Church; ...' The McCoy children were raised and died in the Church of England. However, in his later years McCoy was much involved with Xavier College, and at his death a Roman Catholic priest claimed that he had made a deathbed recantation, but this was strongly denied by a grandson who was present at the time. The truth of the matter will probably remain unresolved.

Shortly after his wife's death in 1886, McCoy, on six month's sabbatical leave and accompanied by his daughter, visited England, to be invested as a Companion of St Michael and St George and to look up old friends, Turkey – a geologist in search of the Ark? and probably a number of other countries. It was the only time he left Australia. While initially occupying one of the professorial houses on the university campus for some years, Frederick, Anna and Emily spent most of their lives in their South Road, Brighton home, *Maritima* - which is now part of Xavier College. In McCoy's papers there are a couple of land transfer and ownership documents, but neither bears his name. What is known is that he did own at least one other property, as related in Doug McCann's paper 'Frederick McCoy's Mount Macedon Property'.

While we know he died on 13 May 1899, in the absence of a birth certificate there is some controversy in Australia about McCoy's birth date. All direct or derived sources from Great Britain unequivocally state 1823, as do most Australian sources, including *The Age* obituary. The alternative date of 1817, used in the Australian Dictionary of Biography, appears to have originated from a single source – the obituary in *The Argus*. Australian sources that give 1817 as the date justify it by pointing out that McCoy had a scientific paper published in the *Magazine of Natural History* in 1838, making him 15 at the time, if born in 1823. See Darragh's paper for further details. Drawing on a number of sources, I have concluded that McCoy was most likely to have been born in 1822 or perhaps 1821. 1821/22 will appear in McCoy's entry in the new edition of the 'Dictionary of National Biography' (due 2004). McCoy's name is found in various documents as either McCoy or M'Coy. Neil Archbold takes a brief look at this issue.

One of the most fruitful areas for further research into McCoy would perhaps be to resolve how it was that he managed to retain control of the National Museum and keep it at the University for 43 years against the wishes of powerful forces; through 26 state governments, numerous university councillors and museum trustees; and yet within six months of his death, the whole of the National Museum collection was relocated in downtown Swanston Street, where it shared cramped premises with the State Library and the National Gallery of Victoria, to the detriment of all.

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A special issue of *The Victorian Naturalist* was first proposed in July 1999 to commemorate the centenary of the death of Sir Frederick McCoy, the first President of The Field Naturalists Club of Victoria. Work started in March 2000, but because of the interest from many authors and the large amount of material we received, it soon became apparent that the issue would be much larger than anticipated (ultimately requiring two issues) and take much longer to prepare. Thanks are due to many people who assisted us. Virgil Hubregtse and Michael McBain diligently proof read all the manuscripts, and members of the editorial committee (Tom May, John Seebeck, Ian Endersby and Ian Mansergh) provided valuable advice. Charles Leski Auctions digitally photographed many of the images contained in these issues and Steve Kitto of Brown Prior Anderson Pty Ltd (our printers) also provided technical assistance. Permission to reproduce pictures was kindly granted by the State Library of Victoria, Museum Victoria, the University of Melbourne Archives and Art Collection and Peter Schouten.

John Seebeck (NRE) and Tom Darragh (Museum Victoria) helped with planning in the early stages. Frank Job, head librarian at Museum Victoria provided access to McCoy's original correspondence and Wayne Longmore, also at Museum Victoria located some of the bird specimens purchased by McCoy for us to photograph.

Dr Doug McCann first proposed the idea of a special issue on McCoy, provided much assistance in planning the issue and commissioned many of the writers. Professor Neil Archbold of Deakin University suggested, and provided the funding for, the colour section of Part Two. We are most appreciative and thank them both.

Frederick McCoy: the Irish Years

Thomas A. Darragh[1]

Frederick McCoy was Australia's first resident palaeontologist and until the arrival in Adelaide in 1875 of Professor Ralph Tate (1840-1901) its only professional palaeontologist. Of McCoy's education, we know nothing except some evidence to suggest he may have attended a school run by the Jesuits in Dublin (Dening and Kennedy 1993). Since his father, Simon, was a physician, it is not unreasonable to suspect that his father may have had some influence in developing an interest in natural history. Whatever his education, he must have been something of a child prodigy, because he published his first paper, on birds, 'Remarks on Mr Eyton's arrangement of the Gulls' in the *Magazine of Natural History* in 1838, when he would have been about 14 or 15, and also gave a lecture on the orders of birds to the fourth meeting of the Natural History Society of Dublin on 16 April 1838. McCoy stated that it was intended he follow his father's profession, and being a lonely child, he spent much of his time studying (Anon 1891). It is alleged that he attended medical courses in Dublin, perhaps conducted by his father, but was too young to enrol formally in a course. Despite this, in November 1839 he gave two lectures on anatomy to the Peter Street Anatomical School, run by his father. That same year he joined the Geological Society of Dublin and was appointed assistant to Dr John Scouler (1804-1871), one of the two secretaries of the Society, to assist in arranging the fossil collections in the Society's Museum (Griffith 1841). Scouler, an eminent naturalist, was Professor of geology, zoology and botany at the Royal Dublin Society and must also have been an important influence on McCoy.

In 1839 McCoy published his first description of a fossil, a Carboniferous ostracod *Entomoconchus scouleri*, in a paper entitled 'On a new genus of Entomostraca from the Mountain Limestone' in the *Journal of the Geological Society of Dublin* (McCoy 1839) (Fig. 1). He continued working at the Geological Society of Dublin into 1841 and also that year arranged the collection of Henry Charles Sirr for sale (McCoy 1841a, b). The appendix of the catalogue of organic remains of the Sirr collection contains descriptions of nine species of fossils (McCoy 1841a). His position with the Society was terminated in February 1842 for neglect of curatorial duties (Herries Davies 1983) and it has been alleged that his work was slipshod. His successor in this position was Thomas Oldham (1816-1878), who later was to quarrel with McCoy over fossil identifications and was certainly prejudiced against McCoy, as later events proved.

The catalogue of the Geological Society Museum, issued in 1841, has an appendix containing descriptions of new species of fossils. There is no author cited for this but McCoy is credited with the arrangement in the introduction to the catalogue and presumably he was the author (McCoy 1841c). He certainly listed it amongst his publications when applying for the Melbourne chair. Whilst McCoy was undertaking this work, he was also working as a palaeontologist for Richard Griffith (1784-1878), who had invited McCoy to determine the fossils collected by him and his staff of the Boundary Survey of Ireland. Griffith needed McCoy's information to determine ages for his Geological Map of Ireland, then in process of compilation. The results of this work were published in 1844 as *Synopsis of the Carboniferous Fossils of Ireland* and in 1846 as *Synopsis of the Silurian Fossils of Ireland*. McCoy was a talented natural history artist and undertook the necessary illustration in these monographs and his other publications himself. The publication of the two monographs was financed by Griffith, who, unfortunately for McCoy and later palaeontologists, 'suppressed ...

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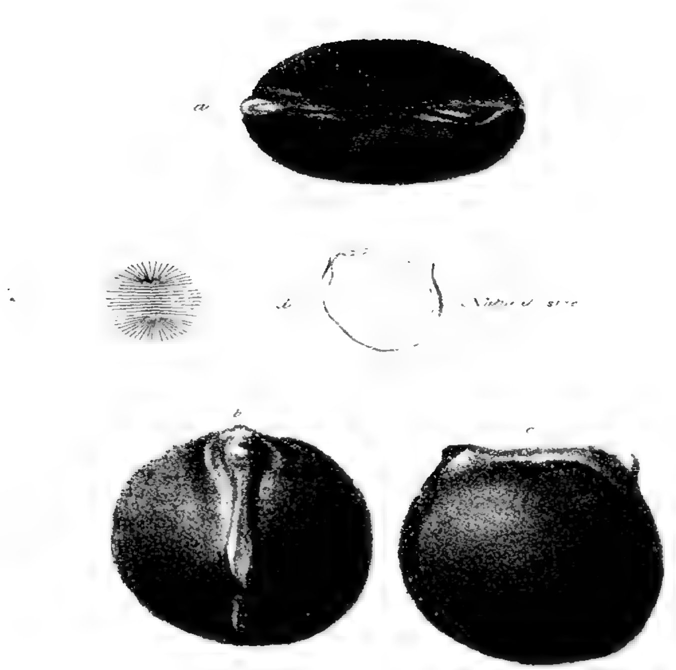

ENTOMOCONCHUS SCOULERII (McCoy)

Fig. 1. Illustration from McCoy's first paper published on a fossil. 1839.

a great deal of McCoy's good work' by cutting out all the locality details of the fossils as a cost-saving measure (Sedgwick 1854). Possibly it was this work for Griffiths that left McCoy open to accusations of neglect of his duties to the Geological Society. It was while working at the Society in 1841 that McCoy first met Adam Sedgwick (1785-1873), Professor of Geology at Cambridge University, who was on a visit to Dublin. Sedgwick seems to have been impressed with the young McCoy, who was working on Richard Griffith's fossil fish at the time (Sedgwick 1854), and was later to play a very important role in McCoy's advancement.

In November 1842, McCoy applied for the position of Curator of the Museum of the Geological Society of London, in place of William Lonsdale. McCoy was one of nine candidates, including Edward Forbes (1815-1854), Edward Charlesworth (1813-1893), N.J. Larkin (1781-1855) and Thomas Oldham, who became well known names in geology (Hutton 1842). Forbes received the appointment. In 1843, McCoy married Anna Harrison and two children, Emily and Frederick Henry, were born soon after, so McCoy had need of more permanent employment to support his family.

Late in 1844 McCoy was in negotiation with the Royal Dublin Society concerning the arrangement and naming of its collection of recent and fossil specimens, but was not employed, possibly because of lack of funds (Griffith 1844). At this time discussions were also under way concerning the establishment of a geological survey for the whole of Ireland. Early in 1845, McCoy had been in touch with Henry James (1803-1877), who was to be the Local Director of the Survey and who seems to have been keen to have McCoy as palaeontologist (James 1845a). However, when the Geological Survey of Ireland was formally established, it was decided that all the fossils would be determined by Edward Forbes, who was then Palaeontologist to the Geological Survey of England and Wales. McCoy wrote on 22 March applying for a position on the Survey and on 22 May he was offered an appointment as an Assistant Geologist by James, who advised that his 'assistance will be required principally in the field, and not as a fossilist' (James 1845b). The appointment was to be probationary for six months, with permanent employment subject to satisfactory performance. The pay was 10 shillings per day for a working week of six days. McCoy accepted the offer on 24 May and was sent to map an area in County Carlow (Herries Davies 1995). It is clear from surviving correspondence that James was pleased with McCoy's progress and that they got on well together. Even Henry De La Beche (1796-1855), Director General of the Geological Survey, was pleased with McCoy's work when shown one of McCoy's sections by James (James 1846).

Unfortunately for McCoy, James resigned his position in June 1846 and the new appointment as Local Director went to McCoy's enemy Thomas Oldham. McCoy's difficult position was well appreciated by James, who went so far as to inform De La Beche that he felt it advisable McCoy be transferred to England, but De La Beche did not treat the matter seriously and McCoy remained in Ireland. McCoy had feuded with Oldham at Geological Society meetings from at least June 1844 to as late as June 1846 over Oldham's comments on some of McCoy's determinations of Carboniferous fossils. Oldham took up his duties in July 1846 and it was not long before he was making complaints about the quality of McCoy's work. On 29 August 1846, he wrote to McCoy pointing out errors in his mapping. At first McCoy defended himself by stating that he was precluded from offering any explanations because Oldham had not given any particulars, but McCoy must have realised that Oldham would keep hounding him, so he resigned on 30 September 1846, on the grounds of 'the strong personal animosity he always exhibited towards me' (McCoy 1846). Some of McCoy's field sheets have survived and they show what could be regarded as slipshod work, but it should be borne in mind that the mapping was at a scale of six inches to the mile which does allow very precise mapping if the geologist is expected to map every detail he comes across. However, McCoy, as well as the other geologists, was probably inadequately briefed and James himself probably had no real idea of exactly what was required. How much of Oldham's criticisms of McCoy were due to real problems and how much to prejudice cannot be ascertained (Herries Davies 1995).

In July 1846, anticipating problems with Oldham, McCoy had tried unsuccessfully for other positions. Richard Griffith suggested McCoy seek a professorship at Cork and that he would speak to Robert Kane (1809-1890) of the Royal Dublin Society, who wrote to McCoy advising that he was glad McCoy had applied and would let him know if he heard anything (Griffith 1846; Kane 1846). Nothing came of this.

On the advice of Henry James, by now at Southampton, McCoy contacted Adam Sedgwick in Cambridge (McCoy 1846), who wrote in November 1846 that he could offer no permanent employment, but only what he had already intended to offer Joseph Beete Jukes, who instead had taken up a position with the Geological Survey. This was '100 £ from my own purse & I trusted that I might obtain another 100 £ from the University - and I thought he might be induced by this sum to take up his quarters here for one year arranging our Museum'. He then went on to say 'could you give me any notion of the sum which (and in the circumstances I have pointed out) would induce you to come for one year to Cambridge?' (Sedgwick 1846). McCoy accepted the offer, which eventually was extended for another two years.

McCoy's first contact with Australian fossils was in 1847, when he studied and published on a collection of fossils from the coalfields of New South Wales and Tasmania, sent to Cambridge by Rev. W.B. Clarke (1798-1878) (see Pierson *this issue*). McCoy determined, erroneously as it turned out, that these fossils were Mesozoic in age (McCoy 1847), a view he continued to hold when he came to Melbourne, and which strengthened in his mind when he examined fossils from Victoria that were truly Mesozoic. This view was the basis of a long dispute with Clarke about the age of the New South Wales and Victorian coalfields, in which neither one could see the merits of the other's arguments (Vallance 1981).

During his time at Cambridge, McCoy attended lectures in Botany (1847), Chemistry, Medicine and Surgery (1848), but never completed a degree. Even as late as 1852 he intended to take out a medical degree, but he never finished the final subjects. It seems that more interesting activities prevented him. Despite this lack of formal qualifications, his experience and ability were such that he secured the appointment of Professor of Mineralogy & Geology at Queen's College, Belfast in August 1849 and he continued to work with Sedgwick during the University vacations.

The palaeontological results of this collaboration with Sedgwick were published in three parts from 1851 to 1855 in a large monograph, *A Systematic Description of the British Palaeozoic Fossils in the Geological Museum of the University of Cambridge* (Cambridge), but, apart from a 100 page introduction, Sedgwick's contribution never appeared. As well as his major works, McCoy published about 30 articles between 1845 and 1854 on a variety of subjects but mostly on Palaeozoic fossils (Anon 1899). Much of McCoy's palaeontological work was directed towards supporting Sedgwick's position in Sedgwick's great battle with Sir Roderick Murchison over the boundary between the Cambrian and the Silurian Systems (Secord 1986; see McCann *this issue*).

Because his salary at Belfast was only £200, McCoy was anxious to obtain more lucrative employment. In June 1851 and September 1852, he unsuccessfully offered his palaeontological services to the British Museum, and in November 1853, following Edward Forbes' appointment to Edinburgh University, McCoy unsuccessfully applied to succeed Forbes as Palaeontologist to the Geological Survey (McCoy 1851, 1852, 1853). In December 1852 he applied for the Vice-Presidentship of Queen's College, Galway. This position was to be held with the Chair of Zoology. Despite having excellent references, he was unsuccessful. Had he been appointed, McCoy would have joined his father who was already a professor there. In support of McCoy, Sedgwick (1852) wrote:

> For about five or six years he has been most intimately connected with Cambridge. During three years he entirely lived amongst us, and during the last two or three years he has spent a large portion of each year amongst us carrying on, with almost incredible labour and perseverance, a great scientific work which he has now brought nearly to completion. He was originally destined for the medical profession, and he still I believe, purposes to take a medical degree, for which purpose he has attended a part of our Cambridge course and obtained a certificate to that effect. He is a man of liberal attainment, of cheerful gentlemanlike manners, and of a tolerant temper and disposition, which enable him to live on terms of familiar friendship with men who widely differ from him in opinion. Thus, altho' he is a Roman Catholic and conforming to the discipline of that church, he has gained the confidence and cordial goodwill of men of all parties in Cambridge. Of course I now speak of the University of Cambridge in which there are persons of very different and very strong opinions. I am absolutely certain that all the Members of the University, who had the pleasure of his acquaintance, will bear testimony to that which I am here asserting. No man can, I believe, lament more than himself, the intolerance and violence of the extreme religious parties in Ireland. I think this remark important, for of his great attainment as a naturalist and comparative anatomist there can be no doubt, and on these points he can appeal to his published works and obtain most ample testimonials. I believe him to be one of the very best palaeontologists in Europe. No one of my friends (and I have been the Cambridge Professor of Geology for 34 years) has so large an historical knowledge of foreign works on Palaeontology, and no one of my friends has for the last 16 or 17 years, worked so hard with hands and head as he has done, among all parts of the animal kingdom revealed to us in the old world.

This high opinion of McCoy was by no means confined to an old employer and collaborator, but was also held by others. It was probably the influence of Sedgwick, coupled with the anti-Catholic prejudice that McCoy constantly experienced, that caused McCoy to convert from Roman

Catholicism to Anglicanism about May 1854. Sedgwick remained a close friend until the latter's death in 1873.

By 1854 McCoy was regarded as one of the leading general palaeontologists in England, specialising in the Palaeozoic. With this background, yet lacking the stipulated degree of one of the five great British universities, he applied for the position of Professor of Natural Science in the newly established University of Melbourne in June 1854, attracted by a salary five times greater than he was then receiving. He was supported by glowing testimonials from some of the leading scientists of the day, including Adam Sedgwick, John S. Henslow of Cambridge, William Whewell of Cambridge, and Sir Roderick Murchison. McCoy competed with over 90 other candidates. Whilst he was seeking support for his application, he was privately grieving for the loss of a daughter who died in late May or early June (Henry 1854), so the joy surrounding his appointment to Melbourne was tempered by bereavement. McCoy, his wife and the two surviving children, Emily and Frederick Henry, (another child had died in 1852) left England aboard *Champion of the Seas*, arriving in Melbourne in December 1854.

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Frederick McCoy and his Contributions to Stratigraphical Palaeontology

Doug McCann[1]

Abstract

Sir Frederick McCoy made a significant contribution to the foundation of stratigraphical palaeontology. He carried out extensive taxonomic work sorting, naming and describing the Palaeozoic fossils of Ireland and Britain, and also played a decisive role in the debate between Adam Sedgwick and Roderick Murchison on where to draw the boundary between the Cambrian and Silurian systems. On his arrival in the Colony of Victoria in December 1854 he found that, contrary to the expectations of most European scientists, much of the stratigraphy and palaeontology paralleled that in the Northern Hemisphere. Hence McCoy was the first to confirm that the geological column was a global phenomenon. (*The Victorian Naturalist* **118** (5), 2001, 165-177.)

Introduction

One of the most noteworthy achievements of nineteenth century geological science was the development of convenient and reliable methods for elucidating the order of succession and relative age of the earth's rock strata. The use of fossil organisms, in particular, for establishing the stratigraphical relationships of sedimentary rock sequences was a crucial step in subsequent developments in many related and newly emerging fields such as historical geology, sedimentology, economic geology, evolutionary biology and a host of other allied subdisciplines. The use of fossils for the characterisation and correlation of rock strata is commonly known as *biostratigraphy* or *stratigraphical palaeontology*. Branagan (1998a) gives a succinct, comprehensive account of the history of stratigraphy and the development of the Geological Time Scale (Zittel 1901; Gohau 1990). In this paper it is argued that Frederick McCoy played an important part in clarifying several key issues in stratigraphical palaeontology during its foundational phase.

Early work in Ireland

From the beginning of his working life McCoy was essentially a museum-based taxonomic palaeontologist. In the literature on McCoy it is often emphasised that he did little or no fieldwork – he was 'a naturalist who stayed indoors' (Fendley 1969: 135). What is sometimes implied here is that, because he mainly worked indoors sorting, describing and classifying fossil specimens and did not necessarily collect the fossils himself, there are probably limitations in the interpretations he made. However, while it is preferable that a practising taxonomic palaeontologist should examine the source locations of fossils in the field, in practice it is not always feasible to do so. Like most other sciences, geology and palaeontology are collective enterprises. By necessity, different aspects of the work are carried out by different specialists. Taxonomic palaeontologists often rely on the work of others whether they are field geologists and palaeontologists, amateur collectors or the general public.

Furthermore, taxonomic palaeontologists often are faced with sorting and description of huge collections. This was the case with Frederick McCoy. His early work in Ireland for the Geological Society of Dublin required him to arrange the collection of the Museum. The collection was already extant; McCoy was hired to sort, describe and arrange the collection already assembled. Similarly, in 1841 he was employed to catalogue the Henry Sirr collection of shells and fossils, and also to curate the collections of the Geological Society of Dublin and the Royal Dublin Society. At about the same time McCoy also began working for Richard Griffith, Director of the General Boundary Survey of Ireland, in order to make palaeontological determinations for a forthcoming Geological Map of Ireland. Again, he worked on fossils collected by others; the collections were made by Richard Griffith

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and staff members of the Boundary Survey. This latter work by McCoy resulted in two significant books *Synopsis of the Carboniferous Fossils of Ireland* (1844) and *Synopsis of the Silurian Fossils of Ireland* (1846). The value and accuracy of the actual descriptions and illustrations of the fossils in these historic works (Wyse Jackson and Monaghan 1994) were not diminished by the fact that McCoy was not the original collector (see Archbold, Brachiopoda, *this issue*).

When the Geological Survey of Ireland was established in 1845, McCoy was appointed as the first field surveyor (Herries Davies 1983). Captain Henry James, the local Director, had expected that McCoy, in light of his already significant experience describing fossils, would work as palaeontologist to the Survey, but the Director General of the Geological Survey of Great Britain and Ireland, Sir Henry De la Beche decided that the fossils should go to London for examination by Edward Forbes, one of the Survey's palaeontologists (Darragh 1992). McCoy was instead assigned to the Irish Survey's mapping program. For McCoy this appointment does not seem to have been a fortunate or happy one. The standard of his fieldwork and the quality of the geological maps he produced were criticised by Thomas Oldham who took over from Henry James as Local Director of the Survey (Herries Davies 1983). Oldham, who later went on to a distinguished career as head of the Geological Survey of India, castigated McCoy for numerous errors, omissions and careless work. McCoy and Oldham had previously clashed at meetings of the Geological Society of Dublin. There was obviously fairly strong personal hostility between them, but as Herries Davies (1983: 142) speculates, 'It nevertheless does seem probable that Oldham's complaint of slipshod work was grounded in fact, … four years earlier a similar complaint had earned McCoy virtual dismissal from his curatorship at the Geological Society of Dublin'. Under Oldham's supervision McCoy's position at the Survey became increasingly untenable and in September 1846 he resigned.

Whatever the validity of the accusations against McCoy there are several points that need to be borne in mind. Firstly, there was considerable underlying hostility between McCoy and Oldham that almost certainly coloured the issues. Secondly, as Herries Davies (1983: 142) points out, 'One of McCoy's problems in 1846 may have been that he was inadequately briefed as to the duties of a field-geologist. De la Beche's *Instructions* of May 1845 had been singularly unhelpful in this respect'. Thirdly, Henry James had apparently hired McCoy hoping to draw upon his palaeontological skills; McCoy probably had similar expectations himself. Being more oriented towards the identification and classification of fossils, rather than geological mapping *per se*, it is possible that McCoy carried out his survey work without conviction or enthusiasm (see Darragh *this issue*).

Adam Sedgwick and the Woodwardian Museum

In any event, this difficult interlude did little or no harm to McCoy's future career path. As a result of his earlier work and publications McCoy had already established his reputation as a promising and competent young palaeontologist and his efforts did not go unnoticed by Professor Adam Sedgwick (1785–1873), the Woodwardian Professor of Geology at Cambridge University. Sedgwick first met McCoy in 1841 and was impressed by his work, later stating, '… when I first saw him (in 1841) he had nearly completed his volume on the Carboniferous Fossils of Ireland. His Irish works put him in the front rank of British palaeontologists' (Sedgwick and McCoy 1855: xvi). In November 1846 Sedgwick invited McCoy to arrange the collections in the Woodwardian Museum at Cambridge. Commenting on his first interactions with McCoy, Sedgwick recalled that, 'When my friend formed his first engagement with this University, he came amongst us young indeed in look; but, even then, a veteran in Palaeontology. He was well trained and ready for the task he had undertaken; and far better stored with a knowledge of the foreign standard works on Palaeontology than any man with whom I had before conversed' (Sedgwick and McCoy 1855: xvi).

The Woodwardian Museum housed a large collection that was originally established by a bequest by John Woodward (1665-1728) more than a century earlier, and had been added to considerably ever since, including many specimens collected by Sedgwick and his students over three decades. Sedgwick also supplemented and expanded the collection by the purchase of other geological collections and selected individual specimens to develop one of the finest geological museums in the world (Rudwick 1975). McCoy's initial appointment was for one year but in total he collaborated on the project with Sedgwick for nearly eight years; for three years full-time, then part-time. In 1849 McCoy was appointed to the foundation chair of Geology and Mineralogy at Queen's College Belfast. His duties included being curator of the Museum, but he continued to travel back to Cambridge to work on the collections during vacations. Sedgwick reported that McCoy approached his work with enthusiasm and 'almost incredible labour and perseverance' (Darragh 1992: 17). Sedgwick further testified that towards the completion of the project 'Professor McCoy was employed upon the Collection, not only during long hours of the day, but frequently during the late hours of the night' (Sedgwick 1855: viii). The end result was published as *A Systematic Description of the British Palaeozoic Rocks and Fossils in the Geological Museum of the University of Cambridge* (1855), a comprehensive and significant work in the history of palaeontology. One of McCoy's contemporaries, Professor Heinrich Bronn of Heidelberg, welcomed the book as 'one of the most important appearances in the literature of Palaeontology' (Fendley 1969: 134), and as Sedgwick remarked in the *Introduction*, 'Whatever may be the merits of the following work, it is one of enormous labour.'

It is clear that Sedgwick was very pleased with McCoy's contribution describing him as 'one of the very best palaeontologists in Europe'. However, it was not just McCoy's important and wide-ranging contribution to systematic palaeontology, or his dedicated work in organising the collections in the Woodwardian Museum, that elicited Sedgwick's appreciation - he had another much more personal reason to be grateful to McCoy. For a number of years before he hired McCoy, Sedgwick had been locked in an increasingly bitter geological dispute with his former friend and collaborator, Roderick Impey Murchison (1792-1871). Because of his association with Sedgwick, McCoy also became involved in the debate, and played a decisive role in its eventual resolution.

The Foundations of Stratigraphy in Great Britain

The publication of William Smith's geological map of England and Wales in 1815 signified the beginning of stratigraphical geology as an organised body of knowledge in Great Britain. Another milestone was the election of Adam Sedgwick as Woodwardian Professor of Geology at Cambridge University in 1818, although at that stage of his career he had little geological knowledge or experience. He soon made up for his lack of background and expertise by pursuing research that led to his recognition as one of the most capable geologists in Britain. He was president of the Geological Society of London from 1829 to 1831, and also the British Association in 1833. Sedgwick has been described by historian Walter Cannon as 'one of the best field geologists of all time' (Speakman 1982: preface).

Sedgwick took an early interest in geological issues associated with lithology and stratigraphy. In this, he was influenced by the work of William Conybeare. In 1822, William Conybeare and William Phillips published their handbook *Outlines of the Geology of England and Wales* that summarised the stratigraphy of England, as it was then understood, from the recent unconsolidated sediments in eastern England to the base of the Old Red Sandstone in the west. This handbook helped lay down the foundations of English stratigraphical geology and influenced the direction and content of both Sedgwick's and Murchison's subsequent geological research.

At that time, the rock strata were broadly classified into four sequences; Primary, Secondary, Tertiary and a 'Transition' sequence between the apparently unfossiliferous primitive Primary rocks and the Secondary rocks which were usually layered and fossiliferous. In theory, the Primary, Secondary and Tertiary rocks seemed straightforward and accessible for study, but the Transition rocks were somewhat of a mystery. The Transition rocks were usually layered or stratified but generally highly deformed, and even though fossils were known to be present they did not appear to be in great abundance. The opportunity for unravelling the true nature of this sequence beckoned to any aspiring, ambitious geologist. There was the added attraction that somewhere in the Transition sequence the exact point at which life began might be discovered. Sedgwick and Murchison decided to take up the challenge by attempting to decipher the Transition rocks in southwest Britain.

Murchison became a leading figure in nineteenth century geology (Stafford 1989). His earliest main influence was William Buckland, professor of geology at Oxford University. Murchison was seven years Sedgwick's junior and cultivated a relationship with him; benefiting from Sedgwick's geological knowledge and experience. Intensely ambitious, Murchison eventually outgrew his mentors to become one of the most influential scientists of modern times. His influence eventually extended around the globe. He achieved this by hard work and a strategic research campaign and also by securing membership and leadership of important scientific societies, such as the Geological Society of London, which he joined in 1824 and served as president from 1831 to 1834, and again from 1841 to 1843. He was a co-founder of the Royal Geographical Society and was president for many years, enabling him to become a principal player in colonial science and exploration (Stafford 1989). His authority was further enhanced when he became Director General of the Geological Survey of Great Britain in 1855 following the death of De la Beche.

Collaboration

Murchison's collaboration with Sedgwick began in the latter half of the 1820s; they conducted field trips to Scotland (1827) and the French Alps (1829) and published lengthy memoirs in the *Transactions* of the Geological Society. In 1831 they turned their attention to the relatively unknown Transition rocks of southwest England and Wales (Fig. 1). The Transition rocks consisted mainly of thick confusing sequences of slate and the coarse, dark sandstone known as greywacke. Greywacke is grey-coloured, poorly sorted sandstone ('dirty sandstone') consisting of quartz and feldspar grains and broken rock fragments mixed with substantial amounts of clay particles. Most of these Transition rocks were folded, faulted and altered.

To make sense of the Transition sequence was a huge task, so they decided upon a division of labour. Sedgwick would tackle the older Primary and lower Transition slaty rocks of North Wales. Murchison decided on an approach from Western England into Wales from the southeast, and would tackle the upper Transition sequences which were less disturbed and, as he discovered, more fossiliferous. For several field seasons they devoted themselves to the task. Working separately, they were soon satisfied that they were studying two different but contiguous geological 'systems'. By 1834 they felt that each had identified and interpreted the major structural, lithological and palaeontological features of their respective regions. So in that year they conducted their first, and what turned out to be their only, joint field trip on the Transition rocks, in order to work out how the two systems meshed together, and where the common boundary might be.

The 1834 field trip was brief, and even though a few issues remained unresolved, the two co-workers were confident that they had done enough work to delineate two discrete geological systems and the joint boundary between them. Consequently, in 1835 Murchison designated his section as the 'Silurian' system, after an ancient British tribe that had inhabited the area. Sedgwick followed soon after with the name 'Cambrian' for the lower section, after the Roman name for Wales. In August 1835 Murchison and Sedgwick presented a joint paper before the British Association for the Advancement of Science titled *On the*

Fig. 1. Areas of Primary and Transition rocks according to Conybeare and Phillips 1822 (after Secord 1986).

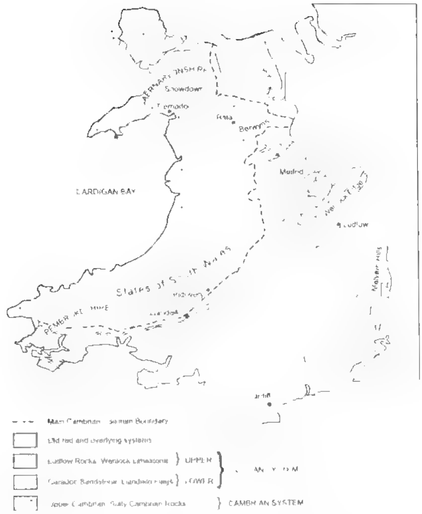

Fig. 2. Geological map of Wales showing the agreed boundary between the Cambrian and the Silurian systems, circa 1839 (after Secord 1986).

Silurian and Cambrian Systems, exhibiting the order in which the older sedimentary strata succeed each other in England and Wales. Both geologists were proud of their achievement. They were aware that their success in unravelling the structure and order of succession for the Lower Palaeozoic rocks in Britain might have global ramifications (Fig. 2).

Murchison, in particular, was determined to promote their stratigraphical interpretation of the Lower Palaeozoic rocks, or at least his version of it. In 1839 he published his classic work *The Silurian System*, one of the most significant geological publications of the nineteenth century. It was a large two-volume work, 820 pages in length, attractively illustrated, and provided a compelling rationale for recognition of his new Silurian system. His Silurian system with its characteristic invertebrate fauna rapidly gained acceptance in Europe and America. The book was dedicated to Sedgwick but in hindsight it was a dedication that probably became more of an embarrassment to Sedgwick than a tribute – particularly as Sedgwick failed to produce a similar *magnum opus* despite repeated promises to do so.

The publication of *The Silurian System* made public for the first time differences of interpretation in exactly where the boundary lay between the Cambrian and Silurian. Sedgwick was surprised to find that certain areas that he and Murchison had formerly agreed were Cambrian were now claimed by Murchison to be Silurian. Initial polite disagreement over these minor regions soon escalated into one of the major geological disputes of the nineteenth century - as Murchison in his publications progressively annexed more and more of Sedgwick's Cambrian strata until little remained.

The Cambrian-Silurian conflict

Privately and publicly, argument and counter-argument took place in this protracted debate over the next two decades as Murchison, gained the ascendancy in the debate. Early in his geological career Murchison was impressed by the importance and efficacy of fossils in determining the age and order of the rock strata (although in this he had to rely on the skills of palaeontologists such as Lonsdale, Sowerby, Salter and McCoy). While he recognised that lithology was important, Murchison became increasingly conscious of the potential of fossils to define and correlate different rock strata. His confidence was strengthened when he discovered that

Silurian rocks containing a recognisable and distinct fauna could be found. Sedgwick, by contrast, like the majority of geologists, such as Aveline, Ramsay, Selwyn and others of the Geological Survey, believed in the primacy of lithology as a basis for identifying and delimiting the stratigraphical sequence. Sedgwick viewed fossils as a secondary tool, useful when other methods were unavailable, but not reliable as the primary instrument in stratigraphical analysis.

Even though Sedgwick collected fossils on his field trips he admitted that although he knew many of them 'by sight' he did not always know them by name (Speakman 1982). Many of the fossils he collected remained unpacked and unsorted in the Cambridge Woodwardian Museum. Sedgwick was also at a disadvantage in the debate in that he was unable to establish a distinct fauna in the less fossiliferous Cambrian rocks. Instead he emphasised the immense thickness of the Cambrian strata. But as Murchison later declared: '...was the Cambrian system ever so defined, that a competent observer going into uninvestigated country could determine whether it existed there?' (Murchison 1852: 176; Berry 1968: 87). Murchison had a point; while geologists could positively identify his characteristic Silurian fossils anywhere they occurred around the globe, the best that could be said of Sedgwick's system was that it was a local entity that may or may not have implications outside his study area in Wales. Murchison was free to claim that Sedgwick's system was merely an earlier extension of the Silurian. By 1842 he was asserting that on the basis of the evidence gathered up until that time it now appeared that Sedgwick's Upper Cambrian fossils were identical with his own Lower Silurian fauna. Only a small section of unfossiliferous rocks remained of Sedgwick's original Cambrian (Fig. 3).

Sedgwick argued long and hard over the ensuing years in order to save his system. He carried out more fieldwork, he examined new areas and re-examined old ones, he put forward a number of new schemes, he invented new terminology, he was even willing to drop the name Cambrian altogether; however at this stage of the dispute he made limited progress in convincing

Fig. 3. Part of an 1843 map designed by Murchison for the Society for the Diffusion of Useful Knowledge (after Secord 1986). Note that in this map Murchison had extended the Silurian to cover most of Wales.

others of the merits of his ideas. As a result of Murchison placing more and more emphasis on fossil evidence to justify his system Sedgwick was forced to take the palaeontological aspect of the work much more seriously. In 1842 he employed a young palaeontologist, John Salter, part-time, to help process the now vast collection of fossils he had accumulated over the years. Salter also accompanied him on a number of field trips to North Wales, collecting fossils in an attempt to clarify the palaeontology and even identify a discrete but simpler fauna than the Silurian (Secord 1986). Even though they discovered some new fossils, there were not enough to constitute a system distinct from the Silurian. Salter made a promising start on cataloguing the Woodwardian Museum collection but left for full-time employment at the Geological Survey of Great Britain. This again left Sedgwick with the need for the services of a palaeontologist; Frederick McCoy was hired to complete the job that had been started by Salter.

Enter Frederick McCoy

McCoy arrived at a critical stage in the Cambrian-Silurian debate. McCoy applied himself to the task of determining the fossils in the Museum but also inevitably became involved in issues related to the disagreement. It should be noted that it was not just Murchison and Sedgwick who had examined the Transition strata in question. By 1841 professional geologists of the official Geological Survey of Great Britain, who had just completed mapping of the coalfields of South Wales, began mapping in the area under dispute. John Phillips, one of the Survey's palaeontologists, reported that, in the Caradoc formation which was located towards the bottom of Murchison's Upper Silurian system, there were occasional anomalies in which Lower Silurian fossils would be found mixed with Upper Silurian. Everyone involved, including Sedgwick, believed that the Caradoc was a coherent set of so-called 'passage beds' positioned between the Silurian and the Cambrian which therefore could feasibly contain an intermediate or a mixed fauna. McCoy, however, began to suspect that possibly there were two different faunas involved, in deceptively conformable beds, but which appeared to be one lithological unit.

On examination of Caradoc fossils from a number of different localities McCoy found that they did separate out into two quite different groups – from some localities the Caradoc fossils had affinities with the Upper Silurian, from other localities the Caradoc fossils had affinities with the Lower Silurian. This strongly suggested the presence of an undetected unconformity within the Caradoc. If McCoy was correct, then Sedgwick finally had a decisive and convincing way of splitting the Transition strata into two natural systems. Sedgwick was not willing to announce these findings until he had confirmed them by examination of the Caradoc rocks in the field. In mid 1852 McCoy accompanied Sedgwick on a brief, rain-interrupted field trip which only allowed them to examine systematically the rock sections at May Hill and the Malverns, but that was enough to validate McCoy's findings and vindicate Sedgwick's claims for a separate Cambrian system. In November 1852 Sedgwick presented his results in a paper to the Geological Society. Sedgwick was able to justify subdividing the former Caradoc formation into two new groups; the upper part he named the May Hill Sandstone, this was considered to be the base of the Silurian; for the lower part he retained the name Caradoc, designated as the top of the Cambrian. The fossil gap between the Cambrian and the Silurian on this evidence was one of the largest breaks in the whole of the fossil record (Fig. 4). Sedgwick's explanation also correlated well with similar findings in Palaeozoic strata in central Europe and America.

The effect of Sedgwick's presentation on the members of the Geological Society was one of grave scepticism. At first they could not accept that the professional geologists of the Geological Survey would not have noticed that such a large geological and palaeontological divide existed between the two proposed systems. However, further work revealed that it was indeed the case. McCoy had also been present at the meeting but interestingly was not a co-author of the paper. Edward Forbes initially believed that McCoy had 'cooked' the fossil evidence in order to please Sedgwick (Secord 1986). The Survey team were in an embarrassing position – in their detailed examination and mapping of the relevant strata they had not noticed any discontinuity in the rock sequence or in the fossil record. They were forced back out in the field to re-examine critical sections and soon discovered previously unnoticed unconformities.

The Survey team tried to play down the significance of Sedgwick and McCoy's research and even suggested that they had only repeated work that had already been carried out by Phillips and others. Over the next few years Aveline, Salter and Ramsay of the Survey team, as well as Sedgwick and McCoy, carried out numerous field trips into Wales, examining rock sections, clarifying the identity and range of key groups of fossils, and revising and redrawing critical boundaries on their geological maps. It does seem somewhat ironic that McCoy, who is sometimes disparaged for the quality and quantity of his fieldwork, happened to participate in fieldwork – although admittedly in the presence of Sedgwick, one of the most famous field

Fig. 4. Transverse section along the banks of the River Onny showing a deceptive but definite unconformity between the Llandeilo and Bala rocks (Caradoc) of the Cambrian below and the overlying May Hill Sandstone of the Silurian above (after Secord 1986).

geologists of his era - that led to the eventual resolution of one of the most intractable and historically significant disputes of the foundational period of stratigraphical palaeontology. All this was primarily the outcome of his work indoors as a 'museum-based taxonomic palaeontologist'!

Murchison, however, was not prepared to concede that he had been in error. By this time he had gained international acclaim for his work on the Silurian. Murchison felt that his whole scientific reputation would be impugned if he yielded to Sedgwick's revised Cambrian. Independently wealthy, Murchison was also institutionally in a powerful position, even more so after he became Director of the Geological Survey. Sedgwick became increasingly embittered at Murchison's unwillingness to recant, and isolated himself from the Geological Society. This played into Murchison's hands and there were suggestions by members of the Geological Survey that Sedgwick was probably going senile or insane.

McCoy's reputation, too, suffered by association. Edward Forbes satirically depicted Sedgwick as Don Quixote, and McCoy as Sancho Panza (Secord 1986). While this representation of Sedgwick displays a certain respect for his moral integrity, it strongly suggests he is fighting for a hopeless cause and perhaps a little obsessed and a little mad. McCoy, by implication, is portrayed as a blind, loyal subordinate who would do anything to please his master. One partial consequence of this is that McCoy has never received due recognition for his contribution to palaeontology and biostratigraphy. Murchison used his influence as head of the Geological Survey, and as a member of other organisations, to control the terms and direction of the debate and to resist any changes in nomenclature or in the details of the standard geological maps of which he did not approve. For ambitious younger geologists and palaeontologists' jobs were scarce and Murchison's patronage and approval were essential if they were to have any real chance of obtaining a desired position or gaining promotion; McCoy was no exception.

As the debate progressed McCoy tried to distance himself from Sedgwick although privately he remained a steadfast supporter. He tried to indicate to Murchison that he was acting objectively and without personal prejudice. Murchison was aware that McCoy was an able and self-assured palaeontologist, and even a dangerous one while he was working in league with Sedgwick. Hence, it suited him to give McCoy a glowing recommendation for the Foundation chair of Natural Science at the newly established University of Melbourne. Whether Murchison's testimonial was given because he believed that McCoy deserved the position based on merit, or simply because he wanted to get him out of the way, is difficult to say. However, it did have the effect of further isolating Sedgwick as well as removing McCoy from the mainstream history of biostratigraphy.

In the years that followed, local and international support for the Cambrian grew, but Murchison died in 1871 still opposing any change in nomenclature. The debate was more or less settled with the inclusion of the Ordovician system by Lapworth in 1879. The Ordovician system was inserted as an intermediate system between the Cambrian and Silurian systems, although it did not gain full interna-

	1	2	3		4	5	6	7	8	9
Sedgwick 1855	Silurian			Upper Cambrian		Middle Cambrian				Lower Camb.
Murchison 1859	Upper Silurian			Lower Silurian				(Primordial Silurian)		Camb.
Geological Survey 1866	Upper Silurian			Lower Silurian						Camb.
Lapworth 1866	Silurian				Ordovician			Cambrian		
	1	2	3		4	5	6	7	8	9
Principal Formations	Ludlow	Wenlock	Upper Llandovery = May Hill	Lower Llandovery	Bala = Caradoc Sandstone	Llandeilo	Arenig	Tremadoc	Lingula Flags	Longmynd

Fig. 5. Some alternative classifications for the Lower Palaeozoic rocks of Britain, 1855-1879 (after Secord 1986). Note Lapworth's inclusion of the Ordovician as a solution to the Sedgwick-Murchison impasse.

tional approval until 1960 (Secord 1986). The new Ordovician encompassed Sedgwick's Upper Cambrian and Murchison's Lower Silurian, but neither protagonist would have been at all enamoured with Lapworth's partial appropriation of their respective geological territories (Fig. 5).

McCoy in Melbourne

When McCoy arrived in the Colony of Victoria in December 1854 as one of the first four professors at the University of Melbourne (see Wilkinson *this issue*) he was only in his early thirties and already an accomplished palaeontologist. Not only was he thoroughly familiar with Irish and British fossils but he also had some experience with Australian material. In Great Britain he had worked on Australian fossils collected by Rev. W.B. Clarke and sent to Sedgwick at Cambridge. In 1847, he published a paper based on this work titled 'On the fossil botany and zoology of the rocks associated with the coal of Australia' in the *Annals and Magazine of Natural History* (see Pierson *this issue*). This familiarity with Australian fossils was possibly one of the factors that enticed him into emigrating to Australia. Soon after his arrival in Victoria, McCoy set about clarifying issues connected with the local palaeontology and stratigraphy and (with Murchison's endorsement) was appointed Palaeontologist to the Geological Survey of Victoria in 1856. He moved quickly in taking over the Colony's fledgling natural history museum and despite some spirited public opposition moved it from its city location to the grounds of the University of Melbourne (Pescott 1954; Wilkinson 1996; Rasmussen *this issue*).

The Global Geological Column

In 1861 McCoy published in the Victorian Exhibition Catalogue the first summary of the zoology and palaeontology of Victoria (McCoy 1861). This paper was reprinted in 1862 in the *Annals and Magazine of Natural History*. In the paper McCoy showed that based on palaeontological evidence the geological column in Australia conformed to that of Great Britain, Europe and North America. For the first time it was confirmed that the rock sequences in the Southern Hemisphere, despite some provincialism, correlated with those of the Northern Hemisphere. In other words, the geological column as deciphered in Great Britain was almost certainly a global phenomenon.

McCoy stated that '... from the great quantity of fossils which I have lately examined as Palaeontologist to the Geological Survey of Victoria: and from evidence of this kind I can offer a sketch of the ancient successive changes of organic life in this country' (McCoy 1862: 138). He proceeded to discuss each of the major geological periods in turn. Beginning with the (Lower) Palaeozoic he asserted that:

> The Azoic [Precambrian] rocks, I can now state, were succeeded in Victoria, exactly as in Wales, Sweden, North America, and other parts of the world in the northern hemisphere, by a series of rocks enclosing fossil remains of the well-known genera and even specific types of animal life characterizing those most ancient fossiliferous strata termed Lower Silurian by Sir R. Murchison, and Cambrian by Professor Sedgwick (McCoy 1862: 138).

McCoy then went on to discuss further correspondences between Australian biostratigraphy and Northern Hemisphere biostratigraphy for the rest of the geological column, i.e., the Upper Palaeozoic, Mesozoic, Tertiary and Recent periods.

At the time of the 1861 publication evidence for the Cretaceous Period had not been positively confirmed in Australia but in 1865 McCoy was able '... to announce for the first time with certainty the existence of the Cretaceous formations in Australia' (McCoy 1865: 333) based on fossils sent to him from Queensland that included bivalves, ammonites and Ichthyosaur vertebrae. Similarly, although fossils from the Devonian Period in Australia had been earlier identified by Konig and Stutchbury their status remained uncertain. In a paper prepared for the 1866-67 Melbourne Intercolonial Exhibition (McCoy 1867a) and reprinted in the *Annals and Magazine of Natural History* in 1867 McCoy claimed that he had definitely confirmed the presence of the Devonian in Australia based on marine fossils from Buchan in Gippsland. McCoy declared:

> It is with great pleasure I announce the fact of my having been able satisfactorily to determine the existence of this formation also in Australia, the limestone of Buchan in Gippsland containing characteristic corals, Placodermatous fish, and abundance of the *Spirifera laevicostata*, perfectly identical with specimens from the European Devonian Limestones of the Eifel (McCoy 1867b: 198).

For McCoy, the confirmation of these formations filled in the remaining major gaps in the geological record for Australia and demonstrated that there was an almost complete correspondence between northern hemisphere and southern hemisphere stratigraphy.

A shortened version of this paper was also made available for a North American audience and published in *The American Journal of Science and Arts* edited by Benjamin Silliman and James Dana (McCoy 1867c: 279-282). When discussing the Cambrian he reiterated:

> ... we have in these formations the most extraordinary proof of the unexpected fact which I announced on a former occasion, that there was in the Cambrian or Lower Silurian period a nearly complete specific uniformity of the marine faunas, not only over the whole northern hemisphere, but across the tropics, extending to this remote temperate latitude of the southern hemisphere (McCoy 1867c: 280).

In his conclusion to both of the above papers McCoy reminded the reader that he had been instrumental in contributing to the solution of the Cambrian-Silurian debate and that exactly the same geological situation prevailed in Australia as in Great Britain. McCoy concluded:

> I can scarcely close ... without drawing attention to the curious confirmation offered

in Victorian geology of the view of Professor Sedgwick and myself, that there was a real systematic line of division between the Upper Silurian and the Cambrian and Lower Silurian, at the base of the Mayhill Sandstone and over the Caradoc Sandstone – the Mayhill Sandstone, which we first defined and demonstrated to have Upper-Silurian fossils only, and the true Caradoc Sandstone full exclusively of Lower-Silurian or Cambrian types... The Mayhill Sandstone was one of the first formations I recognized, on landing near Melbourne, with the usual Upper-Silurian fossils; and it is now found here, as in Wales, to be slightly unconformable to the Cambrian or Lower Silurian, forming the obvious base of the former and totally distinct [in fossils] from the latter (McCoy 1867b: 201-202; McCoy 1867c: 282).

Of course it should be acknowledged that McCoy's claims for the correlation of the Australian stratigraphy with Northern Hemisphere stratigraphy were based not only on his own work but also built on the earlier work of other geologists, particularly collections by T.L. Mitchell, L. Leichhardt, P.E. Strzelecki, J.B. Jukes, W.B. Clarke, S. Stutchbury and others (Vallance 1975; Branagan 1998). Many of the early fossils found in Australia were sent to Britain, Europe and America for identification by palaeontologists such as William Lonsdale, John Morris, Richard Owen, James Dana, Édouard de Verneuil, Laurent de Koninck and Alcide d'Orbigny, and, indeed, McCoy himself. Nevertheless, it was McCoy who was the first to publish a synthesis, indicating that he was the first to fully grasp the broader implications of the local geology, palaeontology and stratigraphy and place it in a global context. Few people could have been better prepared than McCoy to appreciate the Australian stratigraphy and be able to relate it back to the Northern Hemisphere situation. As Sedgwick's assistant, he had played a subordinate but vital role in examining fossil evidence and relating it to the structure and lithology of a geological formation or region.

There was another factor in McCoy's readiness to fit Australian geology into a larger framework. He was attempting to defend a 'progressionist' but non-evolutionary view of the world. McCoy's geological view of the earth, like his mentor Adam Sedgwick's, was more compatible with classical Cuverian catastrophism than with Lyellian uniformitarianism. McCoy was staunchly anti-Darwinian and believed in successive progressive 'creations'; for example, in the 1862 paper when he speaks of the change from the Mesozoic to the Tertiary, he states:

.. we find that here, as in Europe, the greater part of the country sank under the sea during the Tertiary period, and every trace of the previous creations of plants and animals was destroyed and replaced by a totally different new set, both of plants and animals, more nearly related to those now occupying the land and sea of the country (McCoy 1862: 144).

McCoy viewed these postulated successive creations in global terms.

One of the main motivations for publishing his findings on the Australian stratigraphy was to counter the argument (advanced by 'transmutationists' and 'materialists' such as T.H. Huxley and others) that evolution occurred at highly variable rates in different regions of the globe and that Australia was, in effect, an evolutionary backwater. This was a view that had gained credence ever since the time of Lamarck, with the discovery of the bivalve *Trigonia* in Australian waters (Fig. 6) and of various marsupials which were long since extinct in Europe. By demonstrating the universality of the geological column McCoy demolished that argument. Unfortunately for McCoy this induction only helped prepare the way for the acceptance of gradual transmutation or evolution of organic species.

Conclusion

Frederick McCoy made a significant contribution towards summarizing and clarifying the Australian stratigraphy based on his northern hemisphere experience. He was the first to demonstrate that the Australian geology and stratigraphy correlated well with that of the northern hemisphere – contrary to the standard European view. Debate has continued until the present day on just how complete the correlations actually are. It appears that McCoy was largely ignored by the British estab-

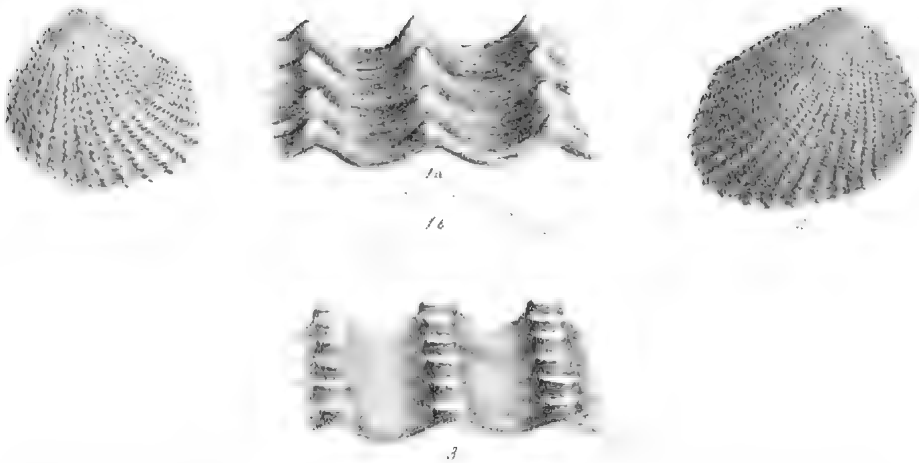

Fig. 6. Illustration of the bivalve *Trigonia acuticostata* McCoy (now *Neotrigonia acuticostata*) comparing it to the previously known *Trigonia Lamarcki* showing the acute ribs and tubercles of *T acuticostata* in contrast to the broad flattened ribs and tubercles of *T. Lamarcki.* McCoy identified and described several new species of *Trigonia*. *Trigonia* was previously known only from Mesozoic formations and in the living state in Australian waters but was unknown in the Tertiary. McCoy was pleased to declare that he had filled that particular gap in the fossil record. In his *Prodromus of the Palaeontology of Victoria, Decade 2* (1875) he wrote, 'Being enabled to announce the discovery of three distinct species of *Trigonia* from the Pliocene and Miocene Tertiaries near Melbourne clears away this supposed exception to a general Palaeontological law, and cannot fail to be welcome, not only to geologists generally, but to the biologists engaged with the large question of the succession of life on our globe.'

lishment in his day, and his contribution has gone almost entirely unnoticed and unacknowledged by historians.

The magnitude of McCoy's achievement is perhaps not fully appreciated today because the global geological column is now taken for granted. The realization that the southern continent was geologically compatible with Europe and America was an important confirmation of the uniformity of nature and the universality of geological phenomena. McCoy's anti-evolutionary stance, which he shared with such luminaries as Sedgwick and Murchison, is another reason that his scientific achievements have not been widely appreciated. Many of these figures have been either harshly dealt with by historians, or dismissed and ignored.

Because of his extensive commitments as Director of the National Museum, Professor of Natural Science at the University of Melbourne, and numerous other duties, McCoy never approached the prodigious output that he achieved in Great Britain. Funding difficulties and bureaucratic and political complications also contributed to delays in publication. Work on his *Prodromus of the Palaeontology of Victoria*, published serially from 1874 to 1882, was actually started in 1858 – the series remained unfinished with the seventh issue. (His *Prodromus of the Zoology of Victoria* was published in twenty issues between 1878 and 1890.)

The breadth of McCoy's contributions to palaeontology and modern zoology, his scientific, philosophical and theological activities directed at the public, and his administration of public institutions and societies, have made McCoy a difficult individual to grapple with. This difficulty should not blind us to the fact that in his day he was an eminent authority and made lasting contributions not only locally but to world science generally. He was one of the pioneering figures of international palaeontology and biostratigraphy, and until the arrival on the local scene of Ralph Tate and Robert Etheridge, Jnr. (Vallance 1978: 247) he was Australia's leading palaeontologist and arguably 'the acknowledged chief of the scientific world of Australasia' (Woodward 1899: 283).

Acknowledgements
I am indebted to Professor Neil Archbold for numerous discussions on McCoy's life and work and for his encouragement. Thanks also to Nicole Dominic for reproducing and reworking many of the illustrations.

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Frederick McCoy and the Phylum Brachiopoda

N.W. Archbold[1]

Abstract

Sir Frederick McCoy, during a long career involved with taxonomy, contributed extensively to the knowledge of the fossil record of the Phylum Brachiopoda. From his classic early monographs on the fossil faunas of the Carboniferous and Silurian of Ireland, to his later works in Victoria where important new species were described and illustrated, McCoy demonstrated the same care, meticulous rigour and quality of illustrations that typified all his work. His contributions on the Brachiopoda are of high and long-lasting significance but form only part of his much broader contribution to palaeontology. (*The Victorian Naturalist* **118** (5), 2001, 178-185.)

Introduction

Representatives of the phylum Brachiopoda are, as most recently defined by Williams *et al.* (2000), 'solitary, marine, bivalved, coelomate invertebrates bilaterally symmetrical about median plane normal to surface of separation between valves; shell organophosphatic or organocarbonate, attached to substrate by muscular stalk (pedicle) or cuticular pad or secondarily cemented or free and composed of commonly larger ventral (pedicle) valve and dorsal (brachial) valve lined by folded extensions (mantle) of body wall pervaded by canaliferous extensions of coelom ... feeding organ lophophore ... disposed and suspended between mantles; alimentary canal with or without anus ... circulatory (haemal) system open ... coelom schizocoelic or enterocoelic; mostly dioecious'. The phylum is well defined and in the latest classification scheme, based on a cladistic approach, is divided into three subphyla: the Linguliformea (the 'lingulids'), the Craniiformea (the 'craniids') and the Rhynchonelliformea (brachiopods with articulated calcite shells). Investigations based on the brachiopod genome indicate that 'the traditional system of two brachiopod classes appears to be valid' (Cohen and Gawthorp 1997). The traditional system refers to the recognition of two classes within the phylum - the Inarticulata and the Articulata. Brachiopods first appeared in the geological record during the Early Cambrian and the phylum has living representatives today. They were dominant in the shallow marine benthonic environments of the Palaeozoic Era, suffered a catastrophic extinction at the end of the Permian Period, rebounded somewhat in the Triassic Period but progressively diminished during the Mesozoic Era. The Cenozoic Era brachiopod faunas are restricted but genera are relatively plentiful. Living forms, usefully divided into 'generalist' and 'specialist' genera, can dominate ecological niches and communities (Richardson 1997). Close to Melbourne, in Western Port, shallow marine benthonic communities can be dominated by the brachiopod species *Magellania flavescens* (Lamarck).

Given the above, it is scarcely surprising that during his long palaeontological career, Frederick McCoy was to appreciate the value of the phylum in the fossil record. He described many species and a number of genera during his lifetime. The present review considers his career in three countries (Ireland, England and Australia) and, while he described few brachiopods during his long time in Australia, he nevertheless still appreciated the value of the phylum for dating sedimentary sequences. Tate (1893: 27) was to note that 'the rapid unfolding of the geological structure of Victoria ... (was) aided by the palaeontological determinations of Professor McCoy'. An excellent history of the classification of the phylum Brachiopoda has been provided by Muir-Wood (1955).

Ireland

The young Frederick McCoy (Fellow of the Geological Society, Dublin) set to work with vigour on the extensive Carboniferous Limestone System fossil collections made by Richard Griffith (later

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Sir) and friends, so that by 1841 much of the work had been completed. He was to describe upwards of four hundred and fifty new species of fossil organisms. After much of the work had been printed off, he was to receive a copy of parts 1 to 12 of de Koninck's (1842) work on the Carboniferous of Belgium. The appearance of de Koninck's work required McCoy to add a note to his own work in order to clarify the minor overlap between the two monographs. McCoy's work appeared in 1844 and included, in modern taxonomic terms, fossil Cephalopoda, Gastropoda, Bivalvia, Conulata, Brachiopoda, Trilobita, Ostracoda, Annelida, Echinodermata, Coelenterata and Bryozoa. This list serves to indicate the breadth of his abilities at taxonomic research at such a young age.

McCoy's treatment of the Brachiopoda in his Carboniferous monograph commences with a succinct review of prior classifications and discusses in detail those proposed by von Buch (1834) and Phillips (1841). He then discusses the function and arrangement of the living components of the brachiopod organism and agreed that the 'tubular arms' of the brachiopod (lophophore as now used) 'served the animal for securing its prey'. McCoy's classification of the Brachiopoda included five families as follows:

1. Delthyridae, or spirifers;
2. Athyridae, or productas;
3. Orbiculidae, the orbiculas;
4. Terebratulidae, true terebratulas; and
5. Pentameridae, chambered brachiopods.

It is of interest that he excluded *Lingula* from the 'true Brachiopoda' - perhaps a forerunner in the argument for two distinct classes? He proceeded to describe species of the Orbiculidae (genus *Orbicula* only), the Athyridae (genera *Crania, Calceola, Producta, Leptagonia, Leptaena* and *Orthis*!), the Delthyridae (genera *Spirifera* - including the subgenera *Cyrtia* and *Fusella* – *Martinia, Athyris, Brachythyris* and *Orthis*). *Reticularia* and *Actinoconchus* were also included in the Delthyridae. The final descriptions were of the Terebratulidae (genera *Atrypa* and *Seminula*). The genus *Orthis* was included by McCoy in his classification of the Delthyridae although the species attributed to the genus were included under the Athyridae in the text (1844). His ideas on the position of the genus are clear and it can be speculated that the species descriptions were included in the incorrect place in the text during typesetting of the book.

McCoy (1844) analysed in meticulous detail the interior structure of the dorsal valve of productids. He interpreted what are now known as the dorsal adductor muscle scars as being modifications of the 'spiral appendages of *Spirifer*'. The brachial ridges were interpreted as being 'the principal pair of adductors'. Although he confused the two sets of structures, he anticipated the description of the schizolophe and ptycholophous styles of lophophore. He noted that in those brachiopods which have the dorsal valve flat, 'the arms are coiled so that their bases rest on its surface … are always fixed … to the internal face of the ventral [now dorsal] valve, and project but slightly from it'.

McCoy (1844) provided synopses and distinguishing characters for 231 species of Irish Carboniferous brachiopods of which 60 were newly diagnosed. All new species, except two, were illustrated, a large number of the illustrations were 'entirely from' McCoy's 'own pencil, and the others have been most carefully corrected, both as to outline, measurements, and effect, by my own hand' (McCoy 1844: v).

By May 1845, McCoy had completed his Synopsis of the Silurian fossils of Ireland (1846) which was to include 96 species of brachiopods of which 29 were new. The 67 previously described species were not figured and no diagnoses were provided only localities were listed with references to previous authors. As with his previous Synopsis, fossil representatives of some 12 phyla in modern terms were described in total. All figures were drawn by McCoy but he noted that the details on the lithographic plates 'had become effaced through absorption', and that he was unable to supervise directly the production of the lithographs.

It would appear then, that by the age of 23, Frederick McCoy was the author of two major monographs (1844, 1846) and several minor works (Darragh 1992). It is clear from the references cited by McCoy that he possessed an excellent knowledge of earlier and contemporary palaeontological literature. With respect to the literature on Brachiopoda, he was clearly familiar with the publications of British and continental European workers. The works of authors such as William Martin (1809), James Sowerby (1812), James de Carle Sowerby (1823), and John Phillips (1836, 1841) in England were often quoted and their species recognised. Works from Sweden (Dalman 1828), Belgium (de Koninck 1842), Germany (von Buch 1834, 1838, 1842; von Schlottheim 1813, 1820: note the two spellings of Schlottheim in the references provided herein - both are correct) and the Russian Empire (Pander 1830; Fischer von Waldheim 1837) were widely utilised as were many others. Sedgwick was to note in 1852 (Sedgwick 1855: xvi) that he considered McCoy to 'be one of the very best palaeontologists in Europe' and that not one of Sedgwick's friends had 'so large an historical knowledge of foreign works on Palaeontology'. Not only did McCoy have a deep knowledge of the literature but it must be noted that his illustrations of new species were also of exceptional quality for their time. They were as accurately drawn as possible, usually showing the imperfections of the specimens and were less simplified (c.f. Phillips 1836, 1841) or idealised (c.f. de Koninck 1842) than those of other authors (see and compare Figs 1 and 2 herein). It is noteworthy that von Zittel (1901: 451) considered that the works of de Koninck, McCoy and Phillips were 'still the basis of all European research on the faunas of the Carboniferous Limestone'.

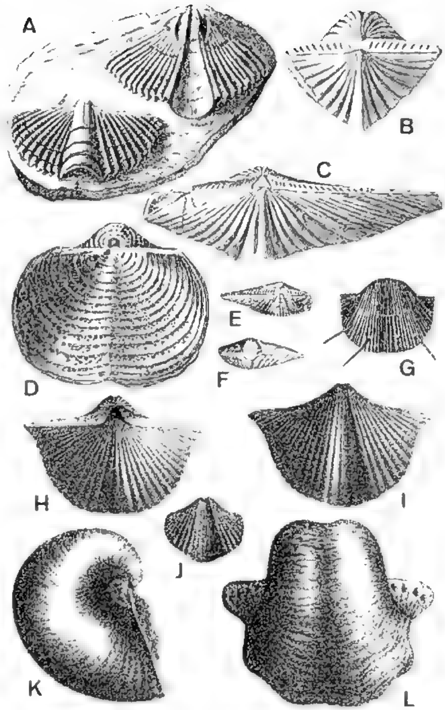

Fig. 1. Representative illustrations of brachiopods available to Frederick McCoy for his classic studies of the 1840s. Original nomenclature of authors preserved. A, *Hysterolites hystericus* (von Schlotheim 1820, pl. 29, figs 1a, b). B, *Spirifera triangularis* Sowerby (Phillips 1836, pl. 9, fig. 12). C, *Spirifera convoluta* (Phillips 1836, pl. 9, fig. 7). D, *Producta punctata* Sowerby, (Phillips 1836, pl. 8, fig. 10). E, F, *Spirifera fusiformis* Sowerby in Phillips 1836, pl. 9, figs 10, 11. G, *Producta setosa* Phillips 1836, pl. 8, fig. 9. H, I, *Spirifer striatus* Martin (de Koninck 1842, pl. 16, figs 3a, b). J, *Spirifer attenuatus* Sowerby (de Koninck 1842, pl. 16, fig. 2f). K, L, *Productus sublaevis* (de Koninck 1842, pl. 10, figs 1d, e). All figures × 0.5.

England

After a brief stint at the Geological Survey of Ireland (May 1845-September 1846), McCoy joined Adam Sedgwick at Cambridge University for what was to become a three year appointment in order to arrange the British and Foreign palaeontological collections as preserved in the Woodwardian Museum (Sedgwick 1855; Darragh 1992).

It would appear that his first task was to describe and illustrate fossils from the Late Palaeozoic of the Sydney Basin, sent to Sedgwick by W.B. Clarke of Sydney (McCoy 1847, 1851d). The Clarke collections included what are now known to be true Carboniferous and true Permian species of brachiopods. Some 25 species of brachiopods are recorded. As was typical of McCoy's style, specimens assigned to previously described species were neither described nor figured but locality data were provided. New species, nine in number, were diagnosed and illustrated. As with previous works the drawings were by McCoy and are of an excellent quality (Fig. 2). These collections were to play a crucial role in the subsequent debate between McCoy and Clarke over the age of the New

South Wales coal measures and those of Victoria, as well as the recognition of Permian rocks in eastern Australia in general (see Vallance 1981: Archbold 1986).

The idea of a work on the British Palaeozoic fossils in the Cambridge Museum was not part of McCoy's original appointment but came about in 1849 at the personal request of Sedgwick (1855: vii). Later that same year, McCoy was elected to a Professorship at Queen's College, Belfast. McCoy was to continue the work on the Cambridge collections part-time over several years. Indeed, he and Sedgwick were to enjoy eight years' working together 'without a moment's abatement of mutual good-will' (Sedgwick 1855: xvi). Sedgwick went on to record 'that in the list of those whom I have rejoiced to call my friends there has not been one more single-minded, more truth-loving and honourable than Professor McCoy'. McCoy, for his part, published only short papers on his progressive results prior to the three large fasciculi of the total volume (Sedgwick and McCoy 1855). Three short papers (McCoy 1851a, b, 1852a) documented 20 new Cambro-Silurian species, 4 new Devonian species and 11 new Carboniferous species of brachiopods respectively. The bulk of the species of brachiopods and the illustrations of the new species were left for the illustrated fasciculi (McCoy 1851c, 1852b, 1855). Sedgwick (1855: v-vi) was to express some concern over the fact that his name was on the title page of McCoy's massive work. He noted that he had 'not been a perfectly free agent in the matter', but that the Syndics of Cambridge University Press had made it a 'positive condition (arising out of existing regulations)'.

In the second fasciculus (1852b), within the class Palliobranchiata, McCoy recognised two orders. Within the first order, Rudistes, he included the family Thecidae (a group of true brachiopods), and within his second order, Brachiopoda, he included 11 families: Craniadae, Orbiculidae, Terebratulidae, Magasidae, Spiriferidae, Uncitidae, Rhynchonellidae, Orthisidae, Productidae, Calceolidae and the Lingulidae. He described just over 20 new species and several varieties from the 'Cambro-Silurian' (c.f. McCoy 1851a) and recorded over ninety additional species from this age group. From the Devonian only four species were new out of a total record of 26 species. In the second fasciculus, McCoy (1852b: 191) endeavoured to clarify the confusion over the names of the two valves of the brachiopod shell. As he had succinctly summarised in his short paper (1852a: 391): 'As the terms "dorsal and ventral" have been almost invariably misapplied by conchological writers in describing brachiopods, and as the confusion is very great when we use these terms in accordance with their anatomical position (but contrary to common use), I propose to use "receiving valve" for the perforated valve of *Terebratula*, &c. (called "dorsal valve" by conchologists and "ventral valve" by anatomists), and I use "entering valve" for the opposite one, of which the beak enters the cavity of the receiving valve'. In modern terminology, the entering valve is the dorsal valve and the receiving valve is the ventral valve.

The third fasciculus (1855) was to include some 115 species and varieties of which about a dozen were new (c.f. 1852a) for the Carboniferous and Permian. McCoy, therefore, had a wide experience of the phylum from throughout the Palaeozoic Era, which was to assist in using the phylum for age determination when he was to relocate to Victoria. All of McCoy's short papers on newly recognised fossil species in the Cambridge collections were brought together and published in book form (McCoy 1854).

Early in his work on the Cambridge collections, McCoy was to determine the functional morphology of the musculature of the brachiopod. This was published by Woodward (1851) who neither claimed the discovery nor attributed it to any other author. Sedgwick (1855: xi-xii) argued lengthily that McCoy was the discoverer of the functional arrangement (McCoy 1852b). From Sedgwick's account, it appears that McCoy determined the function in 1848 or early 1849 and widely shared the discovery with those palaeontologists who were interested in it. Smith (1987) has made much of the argument between Woodward and McCoy but does not refer to Sedgwick's account. Smith (1987: 87), when writing of McCoy's clas-

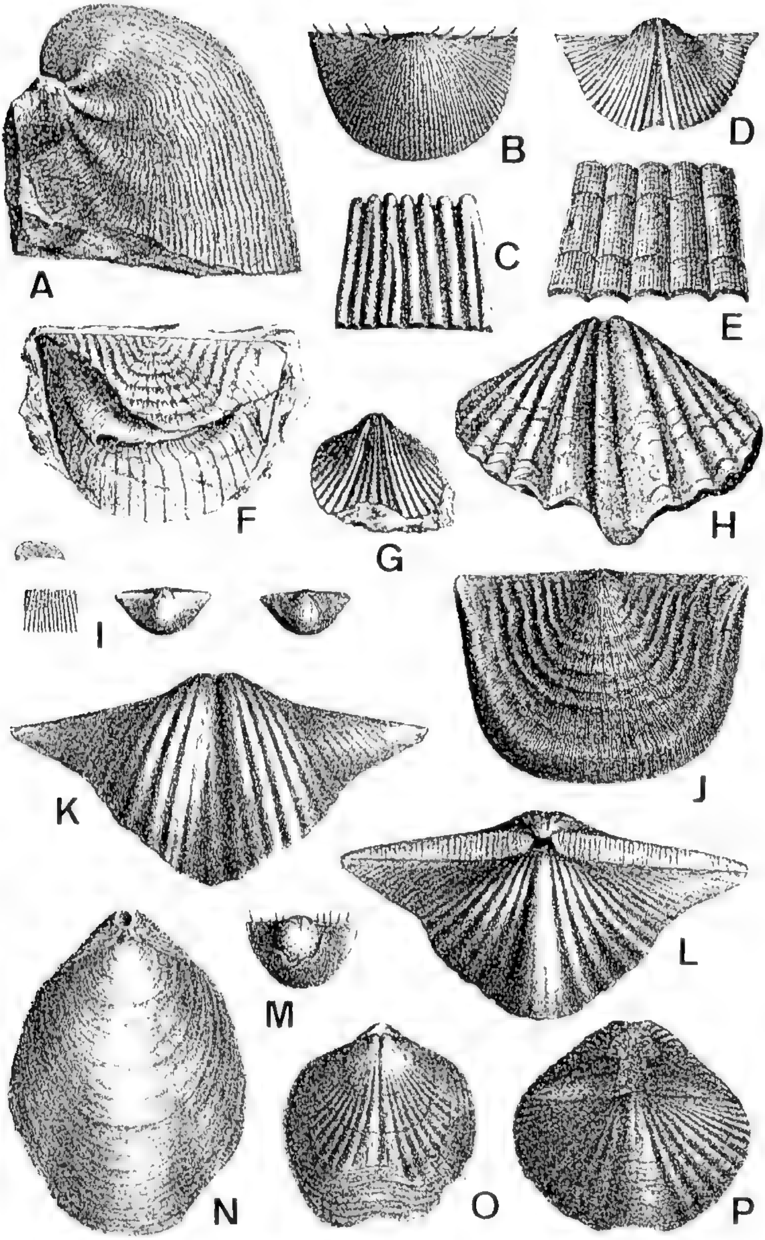

Fig. 2. Representative illustrations of brachiopods by Frederick McCoy from 1844 to 1877. Original nomenclature of McCoy preserved. A, *Producta corrugata* McCoy 1844, pl. 20, fig. 13. B, C, *Leptaena sulcata* McCoy 1844, pl. 20, fig. 6. D, E, *Spirifer clathrata* McCoy 1844, pl. 19, fig. 9. F, *Leptagonia semiovalis* McCoy 1846, pl. 3, fig. 6. G, *Atrypa serrata* McCoy 1846, pl. 3, fig. 29. H, *Spirifera duodecimcostata* McCoy 1847, pl. 17, fig. 2. I, *Leptaena tenuissimestriata* McCoy 1851c, pl. 1H, figs 44, 44a-c. J. *Leptaena undata* McCoy 1851c, pl.1H, fig. 38. K, L, *Spirifera grandicostata* McCoy 1855, pl. 3D, figs 29, 29b. M, *Leptaena (Chonetes) polita* McCoy 1855, pl. 3D, fig. 30. N, *Waldheimia corioensis* McCoy 1877, pl. 43, fig. 1. O, *Trematospira liopleura* McCoy 1877, pl. 46, fig. 3b. P, *Spirifera laevicosta* Valenciennes, (McCoy 1876, pl. 35, fig. 2). All figures × 0.8.

sified and arranged fossils, accused McCoy of 'a high-handed but probably justified proceeding' in that McCoy 'attributed the identification of about half of them to himself'. The statistics for the Brachiopoda, as outlined above, do not support this assertion.

By 1854 McCoy was clearly one of the leading palaeontologists of Europe; his speciality was the fossil record of the Palaeozoic Era. With this background he was to find rich new fields in Victoria, Australia, although his further contributions to the study of Brachiopoda were to be relatively minor.

Australia

McCoy arrived in Melbourne late in 1854 and after taking up his position of Professor of Natural Science at the new University of Melbourne he also became Palaeontologist to the Geological Survey in 1856 and Director of the National Museum of Victoria in 1858 (Darragh 1992).

These three responsibilities and his subsequent broader role of describing and curating the living world (minus Botany, which was the responsibility of Ferdinand von Mueller) as well as the fossil world, dispersed his energies. His contributions to the study of brachiopods were relegated to their use in stratigraphical dating and, after some 20 years in Victoria, the publication of descriptions of a small number of Palaeozoic and Tertiary species.

McCoy wrote little in his first few years in Victoria but the brachiopod *Rhynchonella* featured in his Prefatory Essay (1861: 166; 1862: 144) in reference to Mesozoic marine fauna from Wollumbilla Creek, Queensland. McCoy's identification had also been announced by Clarke (1862: 245) as well as the identification by McCoy of Permian brachiopod fossils (two very like *Productus calva*, Sow., and one allied to *Aulosteges* or *Strophalosia*) from the Mantuan Downs – now known to be a true Permian area in the Bowen Basin. The latter's 'great resemblance to common European Magnesian Limestone and Zechstein species' was noted by McCoy when he published an account of the Queensland fossils (McCoy identified in 1861 but published 1865).

McCoy's later summary of Victorian palaeontology (McCoy 1867a, b) provided several brachiopod identifications. From the 'Cambro-Silurian' (McCoy recognised a lower graptolite facies and a sandy, marly and mud-stone facies) he recorded *Siphonotreta micula* McCoy (from the graptolite beds) and *Strophomena*, *Leptagonia depressa*, *Spirifera reticularis*, and *Orthis elegantula*. From the 'Upper Silurian' he also recorded *Hemithyris diodonta* Dalman and *Pentamerus australis* McCoy. From the Devonian Buchan Limestone he recorded *Spirifera laevicostata*. The Brachiopoda of the Tertiary (Oligo-Miocene) beds, 'although not very abundant, present many representative and peculiar forms … with … another certainly identical with the very rare *Rhynchonella lucida* Gould, found living in the sea of Japan' (McCoy 1867b: 195).

Darragh (1992: 20) noted that in 1858 McCoy commenced a project to describe and illustrate the Victorian fossil and living fauna. Lithographic plates of fossils were produced in the late 1850s by Ludwig Becker, but publication did not commence until 1874 when the first decade of the *Prodromus of the Palaeontology of Victoria* appeared. Publication ceased with the publication of decade 7 in 1882. It appears unjust to argue that 'the record of his research' was 'hardly remarkable' for his first two decades in Victoria when financial restraints were presumably to blame for the lack of publications (c.f. Vallance 1978: 247). Brachiopod descriptions were published in Decades 4 and 5 (McCoy 1876, 1877). Devonian brachiopods *Spirifera laevicosta* (Valenciennes) and *Chonetes australis* McCoy were described in 1876. Tertiary brachiopods (*Waldheimia corioensis* McCoy, *Waldheimia macropora* McCoy) and Silurian brachiopods (*Leptaena* [*Leptagonia*] *rhomboidalis* Wilckens, *Trematospira liopleura* McCoy, *Trematospira formosa* Hall, *Spirifera plicatella* var. *macropleura* Conrad, *Spirifera sulcata* Hisinger, *Spirigerina reticularis* Linnaeus, *Rhynchonella* (*Hemithyris*) *decemplicata* Sowerby, *Nucleospira australis* McCoy and *Pentamerus australis* (McCoy) were described in 1877. McCoy directed the production of the plates which were of a very high quality. As noted by Darragh (1976: 4) the *Prodromus* is 'one of the finest

Australian palaeontological publications' and McCoy's descriptive work was exhaustive and methodical (Darragh 1992: 20).

Smith (1987: 87-88) considered that 'McCoy atrophied. Following his mentor Sedgwick, he never accepted the Ordovician epoch as a break with the Silurian ... McCoy did not fire his pupils' curiosity and seems to have produced no notable successors'. It is a shame that such a work has portrayed such a negative image of McCoy in Australia. As to the first comment, McCoy could scarcely follow Sedgwick in rejecting the Ordovician Period. Sedgwick died in 1873, and Lapworth proposed the Ordovician in 1879 (von Zittel 1901). McCoy was, in fact, well aware that there was a stratigraphical break between the 'Lower Silurian' and the 'Upper Silurian' as defined by the imperious Roderick Impey Murchison, Director of the Geological Survey of Great Britain. As for his students, Darragh (1992) has listed eight students who were to make a mark in geology, biology and engineering. One of McCoy's students, T.S. Hall, applied the term Ordovician to Victorian rocks in 1897. He carried on McCoy's work on graptolites, starting in 1892, and commenced the subdivision and zonation of Victoria's Ordovician sequence. Brown (1946: xi) considered that the 'high standard of palaeontological work which has been maintained since in Victoria owes much to the influence of Professor (later Sir Frederick) McCoy. He has left a wonderful record of published research ...'.

As Darragh (1992: 22) has noted, a good biography of McCoy has yet to be written. McCoy's contribution to the study of brachiopods is enough to ensure his ongoing reputation as a highly significant palaeontologist. He, of course, achieved far more, as this volume of *The Victorian Naturalist* demonstrates.

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Frederick McCoy and the University of Melbourne[1]

Ian Wilkinson*

Abstract
This article deals with some aspects of Frederick McCoy's association with the University of Melbourne. McCoy's early career is described in order to explain the circumstances that led to his appointment as the University of Melbourne's first science professor. McCoy's development of a national museum on the University grounds is noted and some assessment is made of his contribution to science teaching at the University. (*The Victorian Naturalist* **118** (5), 2001, 186-192.)

The establishment of the University of Melbourne

When the Council of the University of Melbourne met for the first time in May 1853 it appointed a Correspondence Committee to 'draw up the Statutes of the University and conduct the correspondence necessary for procuring suitable professors'.[2] In September the Correspondence Committee recommended that a committee sitting in London, headed by the famous scientist Sir John Herschel and the Astronomer Royal George Airy, should elect Melbourne's first four professors. Professors of Classics, mathematics, modern history and natural science were to be appointed. In early 1854 Melbourne's Chancellor, Redmond Barry, informed the selection committee that the Council wished to appoint young men, who were not in holy orders, who would not become involved in political or sectarian controversy, and who were graduates of Oxford, Cambridge, London, Dublin, Edinburgh or Glasgow universities.

On the subject of science, Barry wrote that:

> The great necessity for instruction in Geology, Mineralogy, Metallurgy, Chemistry, Natural History, and Physiology, with the attendant and collateral departments of study, is best proved by the fact, that questions of the most ordinary character are daily being referred to England; the resources of the country are as yet only partially known; and there is much reason to believe that such is mainly to be attributed to the absence hitherto of persons acquainted with the higher walks of science.[3]

He further noted that if the gentleman selected for the science department was possessed of 'practical skill', he was likely to confer 'large benefits on our society'.

The selection committee worked hard during the middle months of 1854, making its recommendations as quickly as possible so that the successful candidates would be able to travel to Melbourne in time to start teaching early in 1855.

In a letter to Barry in August 1854, informing the University Council of the results of the selection committee's deliberations, Herschel explained that all the successful candidates were young men, not in holy orders, who were actively engaged in teaching. He briefly outlined the impressive academic achievements of the men selected for the classics (Henry Rowe), mathematics (William Wilson) and modern history (William Hearn) chairs and then dealt more fully with the career of Frederick McCoy (natural science) who had been selected without holding a university degree. Herschel wrote:

> Mr McCoy having been brought up to the Medical Profession claims no academical distinctions of this nature but, independent of the consideration that such distinctions are not usually or necessarily associated with or evidence of eminence in that department of knowledge, the pretensions of Mr McCoy as an original authority, and as a most successful cultivator of Science are of the very highest kind and such as far to outweigh in the opinion of your committee the absence of such Educational marks of Juvenile application.[4]

Herschel's remarks reflect the fact that, although reform in the mid-nineteenth century had provided a place for the study of science and other 'modern' subjects in the curriculum of the English universities, pre-

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eminence in science was still considered to be won more through practical than academic achievements. Although Frederick McCoy had completed some university study and was, at the time of his appointment to the Melbourne science chair, a professor in one of the colleges of the recently established Queen's University of Ireland, he had gained his scientific reputation more through museum and field work than through academic distinction.

McCoy won the Melbourne science chair over a strong field of candidates, at least four of whom later had careers distinguished enough for their names to appear in the *National Dictionary of Biography*.[5] Amongst the candidates were: William (later Sir William) Aitken (1825-92), Professor of Pathology at the Army Medical School, Fort Pitt, Chatham from 1860 to 1892; William Lauder Lindsay (1829-80), a noted geologist and botanist, who combined these studies with a medical career; Henry Minchin Noad (1815-77), Professor of Chemistry at St George's Hospital, London (appointed 1847), and Consultant Chemist to the Welsh Ironworks, who wrote books on chemistry and electricity; and Edmund Rolands (1819-89), Professor of Chemistry at Queen's College, Galway from 1849 to 1856 and Director of the Bonnington Chemical Works, Edinburgh, from 1856 to 1878.

Although it is difficult to know what was in the minds of the selection committee some 150 years ago, it appears that McCoy possessed three main attributes that set him apart from the rest of the field. First, he had the ability to cover a wide range of scientific disciplines, whereas many of the other candidates were limited in their range of teaching by purely medical backgrounds. Second, he already had the status of a professor - something that few other applicants could claim. Third, he had a record of scientific achievement that was far superior to his rivals.

A brief look at McCoy's career before he came to Melbourne will show why the selection committee thought so highly of him. He drew support for his application from a distinguished group of British scientists and academics. His friend and mentor Adam Sedgwick wrote that he was 'out of all comparison' the best man for a professorship in geology, mineralogy, chemistry and natural history and that he was 'the best palaeontologist in the British Isles'.[6] A number of others endorsed his scientific qualifications and he received praise from his colleagues at Queen's College, Belfast for his teaching ability and general standing as an academic.

McCoy's early career

Frederick McCoy was born in Dublin in 1823. His father, Dr Simon McCoy, was a physician who practised in Dublin and later became foundation Professor of Materia Medica at the Queen's College, Galway. Frederick McCoy also trained for the medical profession, but never took a degree. Writing in support of McCoy's application for the Melbourne science chair, Sedgwick explained that he had had the 'education of a gentleman' and had kept 'terms' at the University of Dublin. He added that, although he believed that McCoy had met all the requirements necessary to take out a medical degree, he had become so immersed in studies in comparative anatomy, physiology and natural history that he had soon found that the medical profession offered 'few charms for him'.[7]

Sedgwick had first met McCoy in Dublin in 1841, the year in which McCoy's catalogues of the museum of the Dublin Geological Society, and the shells and organic remains of the Sirr collection in the Dublin Rotunda, were published. Around 1840 the noted geologist and engineer Sir Richard Griffith had engaged McCoy to classify his personal collection of Irish Palaeozoic fossils. The results of this work were published in *A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland* (1844) and *A Synopsis of the Silurian Fossils of Ireland* (1846). Although McCoy's work for the Dublin Geological Society was deemed less than satisfactory and his position as the Society's Curator was terminated in February 1842, his work in a variety of settings in the early 1840s had established him as one of Ireland's most experienced palaeontologists and museum workers[8] (see McCann *this issue*).

In May 1845 McCoy joined the staff of the British Geological Survey as a field surveyor, and, until he resigned in September 1846, worked mainly on the Geological Map of Ireland. The Survey had been reorganised in 1845, one of the important administrative changes being the incorporation of the Geological Branch of the Ordnance Survey of Ireland into the British Survey and the appointment of Captain Henry James as Local Director for Ireland. Under the direction of Henry de la Beche, the Geological Survey had become an important government scientific agency. De la Beche both strengthened and reorganised the Irish Survey, centred in Dublin, and McCoy was one of seven staff working there in 1845.[9]

McCoy's time at the Survey was not without incident. The quality of his work was questioned by some of his colleagues, including Thomas Oldham who replaced James as the Irish Director in 1846.[10] Nevertheless, McCoy left the Survey with his reputation intact and was able to return to his first love – museum work.

He now moved to Cambridge where he became Adam Sedgwick's assistant at the Woodwardian Museum. Sedgwick, who had been Cambridge's professor of geology since 1818, was a powerful figure in British geology, having carried out notable field investigations in the 1820s and 1830s with, amongst others, his later adversary Roderick Murchison.

At Cambridge McCoy's main task was the preparation of a complete catalogue of the Palaeozoic fossils in the Woodwardian Museum. He carried out this task tirelessly, resulting in the publication of *A Detailed Systematic Description of the British Palaeozoic Fossils in the Geological Museum of the University of Cambridge*, which appeared serially from 1849.[11] Following his appointment as Professor of Mineralogy and Geology in the Queen's College, Belfast in 1849, McCoy's work at the Woodwardian was curtailed, but he continued to visit Cambridge during vacations and often went on field trips with Sedgwick.

As Sedgwick's assistant, McCoy became involved in one of the most celebrated (and bitter) geological controversies in history. For some time, Sedgwick and Roderick Murchison, a former military officer who had taken up the study of geology and become a leader in the field, had been embroiled in an argument over the classification of some important rock strata in Wales. Having begun their investigations as friends and co-workers, Sedgwick and Murchison had become increasingly estranged over whether certain strata should be placed in the Silurian period, which Murchison claimed as his area of expertise, or the older Cambrian period, which Sedgwick believed was his domain. Resolution of the dispute was important because it had implications for the study of geology throughout the world – both Sedgwick's and Murchison's work being highly respected in the relatively new field of stratigraphy (the scientific study of rock strata to deduce their sequence and ages).[12]

Put simply, the dispute centred on the boundary between Silurian and Cambrian periods. Based on the fossil record, Murchison had classified certain rocks in North Wales as lower Silurian while Sedgwick had labelled them Cambrian. Neither man would yield and the dispute lingered on until well after both had died. In the 1850s (and beyond) Murchison held the upper hand in the dispute because his classifications were accepted by many contemporary geologists and by the Geological Survey. The evidence that McCoy and others supplied in support of Sedgwick was either rejected or deflected in order to ensure the integrity of the classifications in Murchison's major work, *The Silurian System*. Murchison was a powerful man within the geological community in Britain and did not want to lose face by having to abandon any part of his Silurian system. Equally, Sedgwick viewed an attack on his Cambrian classifications as evidence that his life's work was being rejected. The dispute was only settled finally by the insertion of a new classification – the Ordovician – between the Cambrian and Silurian.

As a leading member of the Geological Society in London, and later Director of the Geological Survey, Murchison was an extremely powerful scientific patron and not someone McCoy really wanted as an enemy. As a result, McCoy, who had already suffered some disadvantage in England because of his Irish-Catholic background, attempted to disassociate himself from Sedgwick's unpopular views to some extent, in order not to lose favour with Murchison and his supporters. His association with Sedgwick was not, however, particularly advantageous when he tried to obtain employment in London.

McCoy's future seems to have come to a head in early 1854 when the 'star position in British palaeontology' – the curatorship of the Geological Survey's fossil collections in London - became vacant. Sedgwick tried to secure this position for McCoy, but Murchison ensured that other candidates were favoured and McCoy did not obtain the position.[13] Although McCoy had accepted a chair at Queen's College in August 1849, he had done so reluctantly and had actively sought other positions ever since. Sedgwick supported him in these endeavours and suggested, in a letter to Murchison in 1852, that the British public should secure McCoy's services because he was one of the steadiest and quickest workmen to have ever undertaken the arrangement of a museum.[14] Museum work was clearly McCoy's forte and he must have been hopeful of securing a more prestigious appointment, possibly in London where the powerful Geological Society was based. In the end, though, his support for Sedgwick hindered this ambition; although recognising his ability, Murchison and his supporters were quite happy to see him established in a university in the Antipodes where he could offer Sedgwick little further assistance.

The Melbourne Science Chair

Given his desire to remain in the lively scientific community in England, a professorship in Melbourne might not seem to have been a very attractive prospect for McCoy. Nevertheless, the salary of £1000 per annum was about five times more than he was earning in Belfast,[15] and he was also guaranteed living quarters at the University, tenure for life and status as a senior scientist in the newly-established colony of Victoria. Furthermore, although there was no offer of museum work with the position, McCoy no doubt saw the prospect of developing his own little 'empire' in the Antipodes, where little geological or zoological work had yet been undertaken. While working at Cambridge, he had studied fossils collected in New South Wales by Rev. William Clarke, and had written two papers on Australian topics.[16] In Melbourne, he had the opportunity to establish a unique collection that was likely to attract considerable attention overseas because of its 'exotic' nature. Although 'transportation for life to Melbourne' meant McCoy's isolation from the centres of British science, it did provide him with secure employment and the chance to establish a museum collection of significance in an environment where he was in charge and not dependent on the patronage of others.

When McCoy and his family arrived in Melbourne just after Christmas 1854, the building that was supposed to house the new university was not complete and the prospect that the University might enrol more than a handful of students seemed remote. A lack of secondary schools in the colony meant that there was not a ready supply of students prepared to undertake the University's Bachelor of Arts course, and, initially at least, there were many who felt that its establishment had been premature. For example, when the University opened in temporary accommodation at the Exhibition Buildings with only thirteen students in attendance, *The Age* labelled it a 'costly toy' and suggested that it would be cheaper to send the students to England than to waste money on building a university in Melbourne.[17]

McCoy's early teaching at the University embraced a broad range of subjects, including zoology, comparative anatomy, botany, mineralogy, chemistry, geology and palaeontology, but the number of students in his classes was small. Increased enrolments eventually led to the appointment of additional science lecturers and professors, and the number of subjects he taught was reduced. Nevertheless, he still taught zoology, geology, mineralogy and palaeontology (Fig. 1). Toward the end of his career, his teaching was viewed as being somewhat inadequate, particularly when compared with the more 'modern' approach taken by the young science professors appointed in the 1880s – Orme Masson (chemistry), Thomas Lyle (physics) and Baldwin Spencer (biology).[18]

Fig. 1. Staff and students at University of Melbourne, c. 1876. Professor Frederick McCoy is seated first on the left in the front row. UMA/I/1306 University of Melbourne Archives.

The National Museum

Although the curatorship of a museum was not part of McCoy's duties as professor of natural science, his interest in museum work led him to seize the chance to create a 'national' museum in association with the University when the opportunity arose not long after his arrival in Melbourne.

During 1855 the Governor of Victoria, Sir Charles Hotham, who had arrived in 1854 with a brief to curtail the colony's extravagant budget, announced that public money would no longer be provided to maintain the colony's natural history collection. This collection was housed in the Offices of the Government Survey Department, but it would now have to be stored elsewhere.

Eager to show interest in the collection, McCoy visited the Colonial Secretary's Office and suggested that he would look after it (free of charge) if it was moved to the University.[19]

McCoy felt that his experience maintaining public museum collections in England made him the ideal person to manage Victoria's national collection. It had always been the Council's intention to establish a science museum in connection with the University because it believed that at least a small collection was required for teaching purposes. As McCoy provided most of the science teaching, it was his responsibility to establish a teaching museum and he argued that it would be better for both the Government and the University if this was established in conjunction with a public museum.[20]

The story of how delays in the transference of the public collection from the Survey Office to new rooms specially built for its accommodation at the University eventually led McCoy to take matters into his own hands, and bodily carry specimens from the city to the University, has been told elsewhere.[21] Suffice it to say that the idea of establishing a national museum on the University grounds did not have the support of many members of Victoria's fledgling science community and McCoy was vilified for attempting what some portrayed as a 'smash and grab' raid. In 1857 McCoy became the Director of the Museum of Natural and Applied Sciences and in 1864 a separate National Museum building was constructed on the University grounds. The National Museum of Victoria remained there until McCoy's death in 1899. During most of his tenure as professor of natural science, McCoy's activities as museum director were probably more significant in the eyes of the Victorian public than his teaching activities at the University (see Rasmussen *this issue*).

McCoy's contribution to the teaching of science at the University

During his forty-four years as professor of natural science, Frederick McCoy witnessed many significant changes at the University of Melbourne, including the introduction of professional schools, the admission of women, the establishment of residential colleges and a huge increase in the number of students and staff. When classes began in 1855 he was virtually the sole science teacher at the University[22] and one of only a few 'professional' scientists in the Australian colonies. The fact that science subjects were not introduced into the syllabus for the University's matriculation examination until 1881 was indicative of the low status given to science education in schools and universities working on the classical English model throughout most of the nineteenth century. The establishment of an engineering course in 1861, and a medical school in 1862, produced some expansion in the University's science offerings and the first attempts were made to include laboratory work as part of science instruction. In the 1880s, chairs of chemistry, physics and biology were established and science degrees (and a science faculty) were introduced. Although science teaching still played only a minor role in the University's curriculum when McCoy died, its study had gained some credibility at both school and university level. In addition, laboratory research was beginning to become an accepted part of the University's activities.

When, in 1884, students complained of 'botany in a lecture room and not a garden', 'lectures in Zoology without practical demonstrations' and that 'no geology excursion is ever made',[23] they reflected concern that the type of science teaching McCoy offered was out-of-date. Although he was undoubtedly well qualified to take up a natural science chair in the 1850s, McCoy did not have either the knowledge or the skills that young scientists, fresh from Europe, brought to the University in the 1880s. He was basically a theoretician and a museum specialist, who spent most of his time studying indoors whilst in Melbourne.

In the twilight of his career, McCoy's mid-nineteenth-century approach to teaching and 'research' had been superseded by the more 'modern' approach of younger men. These men were not cast in the natural history tradition that had briefly come to the fore in professional science during McCoy's lifetime, but which was quickly returning to the realm of the amateur from where it had originated. For example, unlike McCoy, the biologist Baldwin Spencer, who took over some of his courses in the 1880s, had been educated in the experimental tradition and believed in the theory of evolution.[24] More significantly, when Walter Gregory became Melbourne's professor of geology and mineralogy in 1900, his appointment was heralded by *The Age* as opening 'a new era in the popularizing of University teaching in Victoria'. Adopting a vastly more practical approach to geological study than McCoy, Gregory called for new courses with field work, camping out and the linking of theoretical study with mining work.[25]

Conclusion

While McCoy eventually became associated more with the inadequacies of science teaching at the University of Melbourne than with its extension, it is clear that his distinguished career before his arrival in Australia qualified him to perform the duties required of a mid-nineteenth century natural science professor. In the latter part of his career, he completed two massive works – *Prodromus of the Zoology of Victoria* and *Prodromus of the Palaeontology of Victoria* – and received many civic and scientific awards and decorations. He also served on a number of government boards and royal commissions. He was president of the Royal Society of Victoria, founding president of the Field Naturalists' Club and a leading member of the Acclimatisation (later Zoological) Society. In addition to his Directorship of the National Museum, he was Government Palaeontologist from 1856.[26]

As professor of natural science, McCoy helped popularise science in Victoria through the establishment of a museum that was visited by many members of the community. He left as his legacy an outstanding natural history collection that still forms part of the collection at the Melbourne Museum today.

Notes

[1] For a more detailed discussion of some of the material in this article see Wilkinson, I.R. (1996). Frederick McCoy; first science professor at the University of Melbourne. *History of Education Review*, **25** (1), 54-70.

[2] University of Melbourne, *Minutes of the Proceedings of The Council of The University of Melbourne* (*Council Minutes*), Melbourne, 3 May 1853, p. 1.

[3] *Council Minutes*, 10 April 1854, p. 3.

[4] Herschel to Barry (18 August 1854) in University of Melbourne, *Appointment of Professors Book* (Melbourne University Archives), between pp. 76 and 77.

[5] See 'Appointment of first Professors' – Microfilm, Melbourne University Archives, pp. 220-27. The candidates for the science chair are listed on pp. 225-26.

[6] Sedgwick to Airy (24 May 1854) in the *Correspondence of Sir Frederick McCoy* (2 volumes National Museum of Victoria Library), Vol. 1 and Sedgwick to Herschel (25 May 1854) in *McCoy Correspondence*, Vol. 2. (Note: These volumes have no page numbers.)

[7] Sedgwick to Herschel (25 May 1854), *McCoy Correspondence*, Vol. 1.

[8] Herries Davies, G.L. (1995). *North from the Hook: 150 years of the Geological Survey of Ireland*, Geological Survey of Ireland, p. 21; *Australian Dictionary of Biography* (*ADB*), **5**, 134; *Nature*, **LX**, 25 May 1899, p. 83.

[9] Herries Davies (1995), 21; *ADB*, **5**, 134; Flett, J. (1937). *The First Hundred Years of the Geological Survey of Great Britain*, 46-7 and 253. (Her Majesty's Stationery Office: London.)

[10] Herries Davies (1995), 33-34.

[11] *ADB*, **5**, 134; Secord, J.A. (1986). *Controversy in Victorian Geology. The Cambrian-Silurian Dispute*, p. 244. (Princeton University Press: Princeton.); Clark, J.W. and Hughes, T.K. (1890). *The Life and Letters of the Reverend Adam Sedgwick*, 2 volumes. **II**, 193-94. (Cambridge University Press: Cambridge.)

[12] For a detailed account and analysis of the Cambrian-Silurian dispute see Secord (1986). See also Hallam, A. (1989). *Great Geological Controversies* (second edition). Chapter 3. (Oxford University Press: Oxford.) For McCoy's role see Secord (1986), Chapter 8 and Hallam, 80-81.

[13] Secord (1986), 271-72.

[14] Clark and Hughes (1890), **II**, 194. The letter from Sedgwick to Murchison is quoted as a footnote at the bottom of the page.

[15] He was earning just over £200 per annum in Belfast. See Moody, T.W. and Beckett, J.C. (1959). *Queen's, Belfast 1845-1949. The History of a University*, **II**, 703. (Faber: London.)

[16] These dealt with fossils found in the Australian coal fields. They were published in 1847. A complete list of McCoy's publications can be found in *The Geological Magazine* (1899), **6** (New Series), 285-87. There are 69 in total.

[17] *The Age*, 16 April 1855, p. 5.

[18] *ADB*, **5**, 134.

[19] See 'Memorandum re Professor McCoy's offer (regarding the museum)' dated 29 June 1855. A copy of the memorandum was included in a letter from the Colonial Secretary to the University Chancellor (10 July 1855). This is located in University of Melbourne, *Central Registry Files* (Miscellaneous Files c. 1855-1901 under 'Museum').

[20] See 'Memorandum re Professor McCoy's offer (regarding the museum)'.

[21] For a detailed discussion see Wilkinson, I.R. (1996). The Battle for the Museum: Frederick McCoy and the establishment of the National Museum of Victoria at the University of Melbourne. *Historical Records of Australian Science*, **11** (1), 1-11.

[22] William Wilson, the mathematics professor, taught some natural philosophy (roughly equivalent to modern day physics).

[23] *ADB*, **5**, 134.

[24] Finney, C. (1993). *Paradise Revealed: natural history in nineteenth-century Australia*, p. 142. (Museum of Victoria: Melbourne.)

[25] *ADB*, **9**, 100-1.

[26] *ADB*, **5**, 134-36.

McCoy's 'Living Museum'

Gwen Pascoe*

Abstract
The System Garden, a specialised botanic garden, was established at the University of Melbourne under Professor Frederick McCoy. This paper is concerned with a description of the garden and its purpose, a (speculative) explanation of the botanical system it was designed to display, and the administrative problems relating to its maintenance and decline. (*The Victorian Naturalist* **118** (5), 2001, 193-199.)

> Human bliss is popularly supposed to be represented by a scientific life, by a Professor of Botany, or the Director of a Botanic Garden or Museum.[1]

If this anonymous statement, dated 1864, is true, Frederick McCoy should have been blissful indeed, for his professional life reflected the contemporary passion for the collection, classification and display of natural history specimens. At that time he was Professor of Natural Science and controlled an almost completed botanic garden (which was later known as the 'System Garden'), and a museum which was growing in size and popularity.

Purpose and establishment

From his museum tower, McCoy could have surveyed the System Garden, which was a 'living museum'[2], designed to illustrate 'all the natural *Classes*, *Orders* and most of the *Families* and many of the *Genera* of plants, arranged with the systematic precision of the leaves of a book and fully *labelled*.'[3] When complete, the System Garden was a chamomile-edged arrangement of the plant kingdom, spread over about four acres in the north-west corner of the University grounds. It consisted of three concentric circles with radial paths leading to a central octagonal conservatory surrounded by a moat. Each class of plants occupied a large bed with a central label large enough to be read from the edge, and subsequent divisions into family, genus and species were in smaller compartments with smaller labels.[4] The carefully devised labels also contained information concerning essential structural characteristics and country of origin. Aquatic plants were exhibited in sunken tanks 'in their proper places in relation to terrestrial kinds instead of the usual practice of putting them all in one reservoir … Even the seaweeds were kept growing for many years'. Labels in appropriate places referred to tropical plants which could only be exhibited in the conservatory.[5]

McCoy believed that students and visitors who became familiar with this arrangement of the plant kingdom would be able to understand the basis of scientific classification through observing the natural alliances and affinities of the various groups of plants. Botany lectures were given in the first term of the academic year and samples of all parts of relevant plants were required. As many plants did not flower or fruit at that time, students were to obtain specimens from the System Garden as these became available.[6] The System Garden (Fig. 1) was a formal arrangement of plants, a living herbarium which supplemented the dried specimens of a normal herbarium, and a gigantic teaching aid.

Botanic gardens played an educational role in British and Irish universities. McCoy's determination to have such a garden for his students may have been inspired by the University's first gardener. William Hyndman (c. 1822-83) had been a botanical 'porter' at Trinity College, Dublin, where he had collected botanical specimens for use in lectures and for preservation in an herbarium.[7] He was later employed at the Melbourne Botanic Garden where a system garden or 'class ground' was being established. In March 1856 McCoy endorsed his application for employment at the University with a reference to the necessity of having a 'small, rigidly systematic botanic garden' to pro-

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Fig. 1. The System Garden, 'laid out in a novel plan' c. 1865. Photo Donald McDonald. UMA/I/1154 University of Melbourne Archives.

vide specimens to illustrate botany lectures, and recommended Hyndman's engagement as a 'botanical porter' who would also superintend the laying out of the proposed garden,[8] in association with Edward La Trobe Bateman (1815?-1897).[9]

Contemporary photographs show sections of the System Garden in the 1860s to 1880s, while a fuller 'picture' is given in the planting list which appears in the Building Committee Minutes between entries for 8 November 1864 and 9 January 1865. This '1865 List' shows nearly 1500 species in the garden, hot house, frames and propagating grounds. Some plant families and individual species, especially the conifers and various genera such as *Xanthorrhoea*, *Aloe* and *Agave*, can be identified from the photographs. By aligning photographs with buildings, the position of these plants in the garden can be determined. The 1865 plant list, later correspondence and memories of the garden make it possible to fill some of the blank spaces. Professor Ewart, for example, wrote an impassioned letter about the 'destruction of the system garden' in 1909, when 'sixty-two trees and shrubs' were removed to make room for the conservatorium, which was eventually built further down Royal Parade.[10] He lists a few of these plants, which seem to have been mainly from the western side of the System Garden, though other large trees were also removed. E.J. Sonenberg, in compiling a list of System Garden plants for the Professor of Botany, John Turner, wrote of his memories of the garden, which included a depression (the remains of the moat), trees which he believed to be original, and the groups of trees which were near several identifiable features, such as the forestry glass house and the animal houses.[11] Maps and plans also provide hints about the planting. The 1896 MMBW plan shows the System Garden, but some divisions were non-existent by then. This is not surprising, as such gardens are difficult to maintain, for trees tend to outgrow smaller plants.[12]

Collectively, this information suggests that the System Garden was planted in an anticlockwise direction (perhaps in recognition that the plants were growing in the southern hemisphere), and beginning at the southern gate of the outer circle. On the basis of currently available material, the System Garden planting plan, superimposed on the 1896 MMBW plan, may have been something like Fig. 2.

Whose 'System' did the System Garden display?

McCoy was not a botanist, but his interest in classification may have encouraged him to tabulate the vegetable kingdom, for the arrangement of plants according to perceived relationships was the basis of

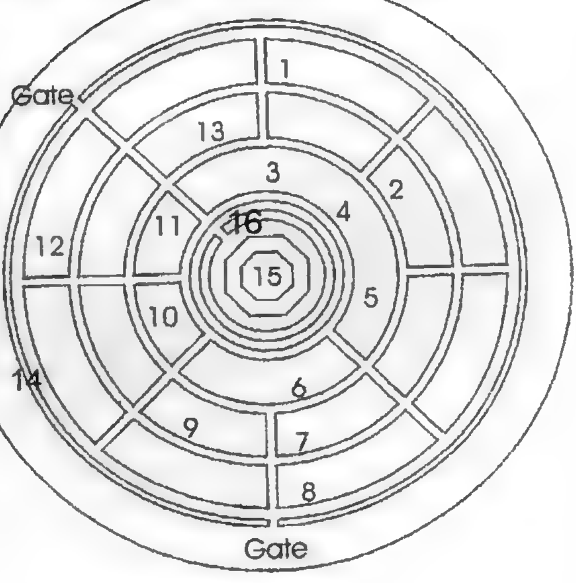

Fig. 2. A plan of the System Garden, showing some families and the main features. 1. Sapindaceae, 2. Umbelliferae, 3. Liliaceae, 4. Coniferae, 5. Casuarinaceae, 6. Artocarpaceae, 7. Myrtaceae, 8. Ranunculaceae, 9. Proteaceae, 10. Gramineae, 11. Palmae, 12. Leguminosae, 13. Compositae, 14. Hedge, 15. Conservatory, 16. Moat.

botanical 'systems'. Artificial systems were based on an obvious or convenient characteristic; the Linnaean system, for example, was based on external characteristics of the stamens. 'Natural systems', such as that which the System Garden was designed to display, were based on the comparison of morphological and physiological characteristics. The search for a 'natural system' resulted in the publication of Antoine de Jussieu's *Genera Plantarum* ... in 1789, but no single system was universally accepted, and by 1860 there were at least twenty-four 'versions' representing various botanists' attempts to devise an acceptable model.[13]

It was believed that nature revealed its own 'shape' in a natural system.[14] Many analogies were tried, including maps, reticula, grids, archipelagos, genealogical trees, constellations, even three-dimensional pyramids. As well as being interested in the 'shape' of nature, many botanists felt it important to find out where families fitted on a general scale of advancement or perfection, but as the 19[th] Century progressed, fewer naturalists believed in such continuity and shape.[15] The analogy used in the University garden was a triple concentric circle with radiating paths.

Features of contemporary botanical systems were progression from 'simple' to 'complex' plants, the range of plant groups included, the number of 'natural orders' (families), and the coincidence of order (family) names, or synonyms. The 1865 System Garden (S.G.) plant list moved from complex to simple, from Ranunculaceae to ferns, and included 267 families. The results of comparing this list with some contemporary versions of a 'natural system' are shown in Table 1.

This comparison shows that the closest 'match' is with Balfour's system, which appeared in the article 'Botany' in the 8[th] edition of the *Encyclopaedia Brittanica* vol. 5, 1854, pp. 63-239, and in his *Outlines of Botany* 2[nd] edition (Edinburgh, 1862).

It is not known why this system would have been chosen for the System Garden. Ferdinand von Mueller was an internationally recognised taxonomic botanist who was also establishing a 'class ground' in the Botanic Garden, but there does not appear to be any record of his having had a role in the University System Garden other than in supplying plants.[16]

The adoption of Balfour's system may have reflected admiration for its creator, John Hutton Balfour (1808-84), and for Edinburgh University, both being known for the excellence of their teaching. The successor to William Hooker at Glasgow University in 1841, Balfour was Professor of Botany (1845-79) and Medicine (1845-75) at Edinburgh, and Regius Keeper of the Royal Botanic Garden. Although

Table 1. 'Natural systems' of plants compared with the 1865 System Garden (S.G.) plant list. *Four names are missing from the 1865 List, which was apparently a copy of an earlier list.

Author	Date Published	Direction Simple (s) Complex (c)	Range	Families (number)	Names (like S.G.)
De Jussieu, A.L.	1789	s to c	Fungi to nettles	100	77
Brown, R.	1810	s to c	Ferns to Goodenoviae	58	55
De Candolle, A.P.	1813	c to s	Ranunculaceae to ferns	155	121
Meisner	1843	c to s	Ranunculaceae to Graminae	275	221
De Jussieu, A.	1844	s to c	Ferns to Compositae	226	165
Lindley	1845	s to c	Ferns to Aristolochiaceae	281	253
Balfour	c. 1854	c to s	Ranunculaceae to ferns	267	263*
Bentham & Hooker	1862-1883	c to s	Ranunculaceae to Graminae	200	178

Balfour's textbooks were standard works,[17] and McCoy brought a copy of *Outlines of Botany* with him,[18] the textbook McCoy later recommended to his botany students was Lindley's *Vegetable Kingdom*.[19] The 'Edinburgh connection' may be via Charles Babington (1808-95), John Henslow's assistant and successor at Cambridge. In 1849 Babington expressed pleasure at receiving Balfour's *Manual of Botany*, and said that both he and Henslow had recommended it.[20] It is possible that McCoy was one of those to whom the book was recommended, for he regarded them as friends and adopted their labelling system for the System Garden.[21] Another possible connection is William Hyndman, who is believed to have been a botanical assistant to William Hooker, Balfour's predecessor at Glasgow, and may have known Balfour, although he seems to have left Glasgow before 1841.[22] Dr Godfrey Howitt (1800-73) is another possible connection, for he had trained in Edinburgh and was a member of the Melbourne University Council. Whatever the connections were, for over twenty years McCoy claimed that his 'design', 'plan' or 'system' was original, as, for example, in the 1860 Building Committee Report which referred to McCoy's 'original design for illustrating the botanical arrangement of trees, plants and shrubs, on a strictly methodical plan indispensable for educational purposes of students (and) also useful for popular improvement and general scientific instruction',[23] but Balfour's contribution was not acknowledged.

In 1875, McCoy explained that he had originally laid out the System Garden 'on a new plan by which the Natural Orders were exhibited in their exact order of mutual affinity, beginning with the highest in organization and ending with the lowest' (Fig. 3). McCoy's 'originality' lay in aiming to display the whole vegetable kingdom, not just herbaceous plants and annuals, which seems to have been the usual practice.[24] It was an 'original' arrangement of an existing system, not an original system. It was a linear progression, for despite Balfour's statement that 'it is impossible to represent the affinities of plants in a linear series',[25] McCoy may have felt that the teaching value of this representation was more important than this objection. His explanation that the System Garden was 'invented by me', or was 'laid out by me on a plan which has been praised and copied by many high authorities' usually occurred when his 'territory' was under threat. Despite this innovation, 'not everything in the garden was rosy'.

Problems of administration

Bateman and Hyndman had important roles in establishing the System Garden, then moved on, while McCoy's continuing involvement made it part of his territory.

Fig. 3. Almost complete! The System Garden c. 1875. Melbourne University Gardens, Victoria. Albumen silver photograph by Charles Nettleton. The University of Melbourne Art Collection. The Russell and Mab Grimwade Miegunyah Fund.

The problems of establishing and maintaining such a garden are hard to imagine now: the soil was poor, with most of the topsoil removed, there was no reticulated water until the supply from Yan Yean was connected in late 1859, there were no herbicides, no artificial fertilisers and no machines - only (frequently inadequate) manpower and committees with little understanding of the requirements of such a specialised garden. On 9 January 1860, for example, McCoy's concern was watering, for the hose only reached the inner circle of beds in the system garden and all other water had to be carried.[26] Requests involving proposed expenditure on the System Garden appeared in the Building Committee minutes for most months, but attempts were made to curb McCoy's enthusiasm and expenditure. For example, after requesting plants which were typical of certain plant families, McCoy was given catalogues from which to make a list, which was then revised by Godfrey Howitt, who found that many of the plants were not available in Victoria.[27] On 12 July 1860, McCoy applied to the Building Committee for funds to erect a portion of the conservatory which was intended to occupy the centre of the garden. This may not have been the first such application, and it certainly was not the last, for the conservatory was not completed for another fifteen years. McCoy was at the University for forty-four years, but his turbulent relationships with administrators and gardeners resulted in the progressive contraction of the territory he controlled.

The medical school was becoming increasingly important by the 1870s, and the System Garden grounds and hothouse were required to provide plants for medical students. By 1880 the garden was overrun with weeds, neglected and largely unoccupied, 'the most prominent objects being an abundant supply of named labels, but without any specimens to represent them'.[28] Despite spirited defence by McCoy, the presentation of an alternative plan of management, and a petition signed by 160 past and present students, the System Garden was not seen as justifying the expenditure of 150 pounds per year. After twenty-five years, McCoy's management of the System Garden was over.

The System Garden was maintained by University staff, as shown in two photographs taken about 1885[29], and teaching

Fig. 4. The end of an era. The System Garden between 1916 and 1922. Photo J. Nanson.

material would still have been available. During the financially troubled 1890s, the Pharmacy College offered to maintain the garden, but withdrew over terms and conditions.[30] As the System Garden was seen as having no further educational role, the Finance Committee resolved to sell plants and buildings. Guilfoyle wrote that the Botanic Garden would gladly accept some of the palms, but the conservatory was not worth moving.[31]

Conclusion

McCoy had a vision of what the System Garden could be. In the face of public and official lack of interest and inadequate funding, the novelty of his 'original plan' wore off even before it was removed from his physical control. It was McCoy's System Garden in the sense that his influence lasted for twenty-five years, and he knew how it was designed to work. He did not try to justify the garden in terms of scientific advancement, but as a practical demonstration. With little public and academic interest, the System Garden was just too ambitious.

McCoy's contribution to the University lay in establishing the base for the teaching of science; for even though he was not remembered for being innovative, his botany students were encouraged to observe. In supporting a petition in favour of McCoy retaining control of the System Garden, Rev. E.C. Spicer wrote

> I can most truly say that nothing was of so great practical help to me in the study of botany as the access to the (system) garden where in the course of a few minutes one could see the whole vegetable world represented from the lowest to the highest in order. Often I have walked up and down the path with my books and notes and nailed if I may say so my knowledge in my mind by living examples properly arranged. I find myself referring to the garden in thought for the position of some Order I may meet.[32]

This was the purpose of the System Garden, for it was a 'living museum' designed to complement herbarium and museum collections for university students and interested members of the public. It was McCoy's arrangement of Balfour's botanical system, and displayed the Professor of Natural Science's mid 19th Century pre-Darwinian view of the plant kingdom.

* * *

A century after McCoy's death, the remains of the System Garden form a secluded oasis between the schools of Botany and Agriculture. Buildings have encroached and planting has obscured McCoy's design, but the white octagonal tower (Fig. 4) which was once the centre of the conservatory still marks the heart of the garden. This 'funny little white building' deserves to be recognised as a memorial to the System Garden of Frederick McCoy.

Notes

[1] 'Botanical lesson books. Lessons in elementary botany; the systematic part based on materials left by the late Professor Henslow …' by Daniel Olive (1994) *Natural History Review* **4**, 355-369 (Review), cited P.F. Stevens, *The Development of Biological Systematics*, p. 212. (New York.)
[2] M. Simo (1998) *Loudon and the Landscape*, p. 105. (Yale.)

[3] F. McCoy, 'Museums in Victoria', *Transactions of the Philosophical Institute of Victoria, 1856*, **1**, 131.
[4] McCoy, p. 132.
[5] 29 May 1875, 1875/17 543 University correspondence (UM).
[6] McCoy to Morrison, 6 September 1880, 1880/19 710 UM.
[7] A.W. Greig, *University Grounds* (unpaged, undated, but probably 1930s), University of Melbourne Archives (UMA).
[8] Greig, pp. 1-2; 4 July 1857 Building Committee Minutes (BCM).
[9] 31 March 1856, 27 May 1857, BCM UMA.
[10] A.J. Ewart to Dr Hill, 2 April 1909, 1909.66 UM.
[11] E.J. Sonenberg, System Garden 1946-87, 47.1 UMA.
[12] R. Schomburgk, cited T. Stephens, *Proceedings Royal Society of Tasmania 1881*, p. 38.
[13] J.R. Green (1914) *A History of Botany in the United Kingdom*, pp. 329, 336. (London.)
[14] Stevens, p. 255.
[15] D.W. Woodland (1991) *Contemporary Plant Systematics*, p. 2. (Englewood Cliffs.)
[16] Around 1972, it was believed that Mueller, rather than Bateman, had been associated with the laying out of the System Garden. Sonenberg 47.1.
[17] Green, p. 432.
[18] McCoy was repaid on 22 May 1856, Payment Vouchers (PV) UMA.
[19] Notebook of George Higgins, student 1875-78 UMA. It was previously thought that the System Garden was based on Lindley's system. S. Ducker, 'The System Garden of Melbourne University', *The Australian Garden Journal*, 5/4 April/May 1986, p. 160.
[20] C.C. Babington (1897) *Memoirs, Journal and Botanical Correspondence of Charles C. Babington*, p. 283. (Cambridge.)
[21] McCoy, p. 132.
[22] John Hyndman, great-great-grandson, personal communication, 24 November 1997.
[23] 28 May 1860, BCM UMA.
[24] W. Guilfoyle (1893) *Glimpses of Some British Gardens and their Conservatories*, p. 52. (Melbourne.)
[25] J.H. Balfour (1852-54) *Class Book of Botany*, p. 729. 3rd edition, 1871. (Edinburgh.)
[26] 9 January 1860, BCM UMA.
[27] 27 August 1860, BCM UMA.
[28] Morrison to McCoy, 6 September 1880, 1880/19 710 UM.
[29] Photographs c. 1885 – in University of Melbourne Archives, and State Library of Victoria.
[30] The proposition was made 2 October 1893 and withdrawn 5 February 1894. CM UMA.
[31] Guilfoyle to Ellery, 12 November 1894, CM UMA.
[32] Rev. E.C. Spicer, 22 April 1881, 1881/26 UM.

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Professor Frederick McCoy and the National Museum of Victoria, 1856-1899

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Based on a talk given for the History of the University Unit, Department of History, University of Melbourne, Occasional Seminar Series, 22 March 2001, based on a recently published history *A Museum for the People: a history of Museum Victoria and its predecessors, 1854-2000.*[1]

I don't presume to be an expert on Professor Frederick McCoy but in the course of working on a series of commissioned histories for the past fifteen years or so I think I have acquired some insight into directors, chief executive officers and the like, especially of public institutions in Victoria.

Foundation directors are a uniquely interesting group because they have the greatest opportunity to stamp their character on the new institution. That stamp is usually remarkably persistent – especially so in the case of Professor McCoy who took over the National Museum of Victoria only two years after its formation and presided over its development for 43 years from 1856 to 1899. Foundation directors are also uniquely interesting because the creation of new institutions suggests interesting and dynamic times, an historical moment when underlying processes of change and resistance can more easily be discerned.

I made my first acquaintance with Professor Frederick McCoy, not when I began to work on the history of Museum Victoria, but several years earlier while supervising Gwen Pascoe's honours thesis on McCoy's System Garden (see Pascoe *this issue*). I embarked on the Museum project fully aware that fitting such a complex, or should I say, contradictory, man into any neat paradigms was never going to be easy. On the other hand there is something truly seductive about the historical character who defies generalisations and stares at you, hands on hips, taunting you with the currently unfashionable question, 'What if…?'

Today I will take the risk and argue that without Professor McCoy – for all his obvious flaws – Victoria would not have had the museum it has today. McCoy arrived at a singular moment of opportunity for one person to make a very big mark on a small canvas and, like Redmond Barry (see Carkeek *this issue*) with whom he was eventually locked in near mortal combat, he wielded a very thick brush with a confidence that bordered on hubris, except that his efforts were, I think, for the most part genuinely directed towards the benefit of the citizens of the Colony of Victoria. The *value* he added to the National Museum was a significant bequest to the nation, defined in his lifetime as the Colony of Victoria, but ultimately the whole of Australia.

'A dedicated director was of paramount importance'[2]

I am indebted to historian Susan Sheets-Pyenson for the title of this section. In her comparative study of the development of colonial museums during the late nineteenth century she observed that, 'Only those directors who possessed considerable energy and charisma could mobilize the power and financial support necessary for the survival of their institutions.'[3] Pronouncements about the centrality of director or curator in defining a museum abound in the nineteenth and early twentieth centuries, but Sheets-Pyenson stresses the extra special qualities needed by colonial 'museum builders' who 'produced remarkable institutions from almost nothing. Nearly every conceivable factor – political, economic or academic – militated against the museum builder's success in his undertaking, but remarkable individual perseverance brought eventual triumph over adversity.' The directors' intense commitment to their museums 'continued unabated for decades'. Only such 'an unwavering sense of purpose' could 'wring the

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resources they needed from parsimonious colonists'.[4] I think that Sheets-Pyenson overstates the case for museum director as *hero* and underrates the factors favouring museum development – not the least of which was the rich material to be collected, described and traded that was all around them – but if her image of natural history museums as 'cathedrals of science' stands – and I think it does – then it is not unreasonable to speak of McCoy as a *high priest.* The association of museum directors with the passion, conviction and faith of religious profession can serve to remind us that in McCoy's formative years religion and science had not yet parted company. There was still only a very rudimentary notion of a secular world view and, in McCoy's opinion (made concrete in the form of his museum exhibitions) the relationship between natural science and natural theology was not challenged by Charles Darwin's theories of natural selection and the origin of species.

At this point, since McCoy's reputation with subsequent generations has been distorted by his steadfast rejection of the theory of evolution (see Butcher *this issue*), it is important to stress that he arrived in the colony full of the latest and most exciting knowledge in his field. He was not just a man of his times but a man with a justifiable sense of himself as one of those working on the frontiers of that knowledge. His claim to be developing his *own* botanical system in the System Garden at the University of Melbourne, and similarly his claims regarding the particular arrangement of specimens in his museum, make this quite clear. He was undoubtedly imbued with a sense that there were systems and theories to be developed and that he was as well equipped as anyone he knew to help to give some final shape to those classificatory systems.

When McCoy arrived to take up his position as Professor of Natural Science at the University of Melbourne in 1854 the subject of museums would have been prominent in his thinking. Scientific teaching in that period was scarcely imaginable without some form of museum, or museum-style collection, to use for demonstrations in lectures and for systematic study by students, just as today science teaching is scarcely imaginable without access to laboratories. McCoy also needed a museum if he was to have any chance of continuing his palaeontological studies.

The original plans for the University of Melbourne had included a museum, and McCoy was dismayed to see that as things stood financially with the University, it did not have a high priority. He set to work to convince the University Council that his science course could not possibly be conducted adequately without additional accommodation for his equipment, his glass cases of mineral and botanical specimens, his pneumatic pumps and galvanic and electromagnetic apparatus.[5] He succeeded, and finance was found for a two storey building on the north side of the quadrangle (now the Law Library) which included lecture theatres and a physics laboratory on the first floor, and within a short time, the collections of the infant 'National Museum', as it became known, on the second.

The University Council also provided funds for Professor McCoy to establish a botanic garden which he intended to arrange 'with the systematic precision of leaves of a book and *fully* labelled in the way adopted in the University Botanic Garden at Cambridge'.[6] As Gwen Pascoe has suggested, 'Such a formal arrangement of plants, a living herbarium which supplemented the dried specimens of a normal herbarium, was a gigantic teaching aid'.[7] So too was a museum, but it was much more than that. Notwithstanding their obvious utilitarian and intrinsic value, museums were valued and contested symbols of power and status. Historian Dick Selleck argues, in his forthcoming history of the University of Melbourne, that in the mid-nineteenth century

> powerful men sought to hold museum keepership in their gift and, as McCoy [had] found to his cost in England, to use the giving to increase their power and their control over knowledge. Museums were also sites of the contest to improve the standing of the teaching of modern studies, particularly the natural sciences, so that it is not surprising that at Oxford and Cambridge the extension of science teaching was planned around museum areas.[8]

At the same time as systematic science gained in status, museums throughout the European world were being transformed from idiosyncratic private collections and acquiring greater significance in intellectual and cultural life generally. McCoy wanted to be part of this process of transformation.

So too did a number of other people in the colony – or rather those who fancied themselves 'men of science' and in tune with modern developments. There were already private museum-style collections of some significance, and the Mechanics' Institute was home to a small museum. The scientifically oriented Governor La Trobe had encouraged ambitions for bigger things which had borne fruit in the establishment of a small natural history and economic geology museum. When McCoy arrived it was housed in two rooms of the Government Assay Office under the care of Surveyor-General Andrew Clarke and Government Zoologist William Blandowski.

The funding crisis that had threatened plans for a university museum also threatened the continued existence of the government-sponsored museum. The group of well-connected enthusiasts, members of the Philosophical Institute of Victoria, who saw themselves as unofficial trustees of this museum, had little power to protect or promote it in hard times. And hard times came about with a regularity that has kept all of Victoria's cultural institutions on a financial knife-edge to the present day.

McCoy was quick to see the opportunity to acquire a museum under his care, and the government was relieved to hand it over to someone willing to develop it as part of the role of Government Palaeontologist and university professor. The local museum supporters were outraged, but those with cooler heads, such as Andrew Clarke, saw more than a neat financial solution. McCoy brought intellectual authority, professional experience and international connections that could only enhance the status and prospects of the colonial museum. With hindsight it is clear that the museum was more secure than if its fate had been left in the hands of a committee of quarrelsome men with inflated egos. That McCoy soon proved inclined that way himself was unfortunate, but at least he didn't waste opportunities arguing amongst his selves over the museum's needs – and there were battles aplenty still to be fought on behalf of the Museum. Quite apart from Sheets-Pyenson's conclusions about the benefits of a single, strong-willed director, closer to home, the difficulties Gerard Krefft experienced with his trustees at the Australian Museum in Sydney – to the detriment of that museum's development – certainly bears out the point.[9]

McCoy's subsequent behaviour in building and defending this museum – his dedication to it long after many of his other passions had waned; his willingness to beg, borrow, barter, provide out of his own pocket and seriously overspend his budget, suggest an almost complete identification of himself with the National Museum. It was, as he explained to Redmond Barry, Chancellor of the University in 1856, not only his 'business' but his 'pleasure also'.

> I devote much time to the arrangement of the museum and the naming and classification of specimens, but this I do … Because I like [where others] might wish to take exercise in the open air, or practice music, or please himself otherwise in the disposal of his time after lectures …[10]

All this seems to justify what was an administratively correct removal of the infant museum collection to the University[11] despite the use of colourful words such as 'raid' and 'brigandage' at the time, and ever since.[12] It also tells something about the way McCoy conceptualised his own role in science and science education, and the place of a museum in that.

'The museum I am growing here'

The National Museum soon outgrew the four rooms in the north wing of the Quadrangle Building. McCoy expended much detailed thought on his requirements for the new Museum building (in the secular Gothic style of the new museum at Oxford) which opened in 1864, as well as the arrangement of the specimens with which it would be stocked (Fig. 1). The modern museum, such as McCoy wished to develop, would be defined by its specialisation, its careful and accurate classification and its visual explication of the state of knowledge at the time. The 'showy and useless' would not crowd out the 'apparently insignificant creatures that for good or evil most concern mankind'. Neither

Fig. 1. National Museum of Victoria, Melbourne, c. 1865-1889. Lithograph and watercolour by Clarence Woodhouse. The University of Melbourne Art Collection, Grimwade Bequest, 1973.

would McCoy's museum be a jumble. Labels on zoological specimens would include family, genus, species, locality and popular name. A system of Roman numerals permitted 'reference to lists painted on the walls giving the orders of all the classes of animals in full'. Mineral specimens were similarly labelled with name, locality, 'crystalline system and the chemical formula of its partial composition set forth in symbols explained by adjoining painted tables and lists'. Palaeontological specimens were

> first divided into geological groups or period according to the distribution in time and analogous to the distribution in space indicated by the arrangement of the collections of specimens of living species. The fossils of each formation are then arranged in zoological systematic order, and fully named with genus, species, locality and formation.'[1]

In short, McCoy wished to provide the colonial frontier with access to a world view that was only just making itself felt in the metropolitan centres of Europe and North America. He also exhibited a deft touch in marrying his metropolitan knowledge with provincial needs and aspirations. His museum was as focused on what we would understand today as applied science – the technology for extracting ore and minerals from the earth, identifying building materials and improving agricultural production – as it was on laying out the classificatory systems of natural science. The mining models were among his most prized exhibits, for his museum was always intended to be both a site of research and of education – a place for the elite and for the ordinary, curious citizen. McCoy never intended to shut the public out of the National Museum, as his detractors in the Philosophical Institute and the daily press had claimed; quite the contrary.

Apart from his scientific mentors, McCoy was influenced by men such as the British Museum's director, Edward Forbes, whose thoughts on 'The educational Uses of Museums' were published in 1851. Within the last few years, wrote McCoy, museums had been discovered to be 'the most ready and effectual means of communicating the knowledge and experience of the experienced few to the many.' Under his direction 'the eye of the unlearned could be familiarised with natural objects, with the principles of classification applied to them by scientific men, to place their peculiar characters and mutual relations in a striking light.'[14] This was not empty rhetoric. McCoy went to great lengths to entice visitors. The Museum was open all day from Monday to Saturday and every week he supplied the *Argus* with reports of the latest attendance statistics and descriptions of new acquisitions. Many were brief, others little essays on the latest developments or the lessons that might be learned from observing new exhibits. Something of McCoy's style of exposition can be gleaned from one such report in the *Argus* of 1 January 1860.

> The case devoted to osteology has had several additions, amongst which the skeleton of the armadillo is of great interest to naturalists and geologists, from illustrating the great geological extinct mammals belonging to the edentate group – such as the *Megatherium*, *Mylodon*, *Glyptodon*, &c. The singular structure of the bones of the limbs and shoulders, recalling, on a small scale, the peculiarities of the extinct gigantic creatures mentioned. This skeleton of the armadillo also illustrates better than that of any other Edentata the extremely interesting arguments of Dr. Buckland in his Bridgewater Treatise, and Professor Owen, touching the special peculiarity of the spinous processes of the vertebrae of the trunk to enable them to support the external body carapace (which may be seen in the stuffed specimens of armadillo in the South American cases) peculiar to the Edentata amongst warm-blooded animals, and the recognition of which peculiar development in the gigantic fossil vertebrae enabled Lord Buckland and Owen to predict the existence of a great bony external armour protecting the extinct animals alluded to before the nearly perfect shields of the *Glyptodon* now in the College of Surgeons, were known. The lovers of osteology will also find in the additions of the week to this case beautifully mounted skeletons of the jackal, the sea-eagle, the Virginian eagle-owl, and of the cobra de capella (*Naja tripudiens*), and also the skulls of the walrus, the zebra, Arabian horse, and the hippopotamus, the latter affording an interesting comparison with the fossil *Hexaprototon* from the sandstone of the Sivalik Hills in the east room. To the mining department several models of gold washing and crushing machinery have been added, and a large working model of the Freyburg *Erz muehle* or mill for grinding ores for the metallurgist; also examples of the new patent galvanic plates of Meyerhoff's patent gold-washing and amalgamating cradle, presented by the inventor, together with samples of gold amalgam and extremely fine gold saved by this machine. A fine specimen of the mantis called *Podacanthus viridiroseus*, caught in Gardiner, has been presented by Mr Vail, and another species from Beechworth, presented by Mr Roberts.

McCoy's efforts as a publicist not only attracted visitors, they helped raise the profile of science and the level of knowledge even among those who did not visit.

McCoy proved an excellent publicist with a sure instinct for what would attract popular interest. Even P.T. Barnum, whose style and circuses are so often presented as the antithesis of sober, 'dusty' museums, would have taken his hat off to the sensation created by McCoy's coup in securing a large case of Paul Du Chaillu's gorillas in 1865 – some of the very first to be seen by Europeans. They were to serve as centre piece for his orchestration of a lively debate on the theory of evolution in Melbourne and further strengthened his reputation as a man in touch with the latest developments throughout the world.[15]

By the middle of the nineteenth century science was established as an international enterprise and the building or redeveloping of museums very much the vogue.[16] Scientists in different countries engaged in regular communication and McCoy was a prodigious letter writer. Australia's place in this intellectual community may have seemed dependent and peripheral by most measures, but its role as a site of sustained interest and valuable research material for international visitors ensured that antipodean scientists would soon assume a greater degree of independence and custodianship. McCoy could draw quickly and easily on the latest museum models to plan his own, and he articulated a clear conception of where his museum sat in this scheme of things. 'The Museum I am "growing here"', he wrote to Adam

Sedgwick, was to be truly scientific, approximating the comprehensive collection which Richard Owen was at that time constructing at the Natural History Museum at South Kensington in London.[17] One of his first acts on behalf of the Museum was to seek from Owen a 'few separated skulls and other parts of skeletons ticketed and coloured and connected' to illustrate his Vertebral Theory.[18] McCoy adopted Owen's principle of displaying specimens that called attention to an animal group by accentuating a particular quality. Whale skeletons, for example, showed the enormous size attained by aquatic animals and it is easy to imagine McCoy's enthusiastic pursuit of the bones of the oversized Blue Whale *Balaenoptera musculus* that washed up on the beach at Jan Juc in 1866. The 90 foot skeleton was of necessity set up outside at the back of the museum and has not survived. At the time it was among the largest articulated specimens in any museum (see Seebeck and Warneke *next issue*).

McCoy also followed Richard Owen's example in remaining inside his museum rather than out in the field collecting. Part of the reason lay in his dual role as professor. The University had only allowed McCoy's appointment as Government Palaeontologist after assurances that the work would not interfere with his professorial duties. McCoy taught across a wide range of subjects in addition to various other commitments within the University and outside in the wider community that would not easily have allowed for lengthy expeditions. Significantly, his own reputation rested on museum study not field work, for which he had been severely criticised while working with the Geological Survey of Great Britain.[19] In any case a steady stream of material for him to work on arrived from the Geological Survey of Victoria.[20] The subsequent elevation of field trips in the work of scientists has led to some undervaluing of McCoy's legacy which included the first comprehensive account of the zoology and palaeontology of Victoria published in the Victorian Exhibition Catalogue of 1861. On the basis of his work on Victorian palaeontology McCoy was able to demonstrate that the geological column in Australia conformed to that of Great Britain, Europe and North America (see McCann *this issue*). 'For the first time it was unequivocally verified that the rock sequences in the Southern Hemisphere correlated precisely with those of the Northern Hemisphere. In other words, the geological column was a global phenomenon.'[21] This work would earn him a doctorate from Cambridge (1886) and the coveted fellowship of the Royal Society (1880).

For McCoy, as for many significant scientists of his era, the museum was central to his investigations and the ideas developed on the basis of that work. Richard Owen 'assumed that the collection, display and description of natural history objects added to the "intellectual wealth" of a nation and that the "indoor naturalist/museum curator played a significant part in this important scientific enterprise'.[22] McCoy cast himself, in the manner of Owen in London, Agassiz at Harvard and others, as builder of a 'national' collection for the benefit of all Victorians despite modifications and limitations on the model imposed by the colonial context.

McCoy's primary intention was to develop for Victorians a wide-ranging international reference or 'Index' collection in clear harmony with Ferdinand von Mueller's claim that 'the ripened work of our successors' depended on 'the timely storing up of collections for scientific use'. For McCoy such a collection was necessary if local investigators were to identify their discoveries correctly and authoritatively as they turned 'the unread pages of the Book of Nature'.[23] In explaining this McCoy drew an analogy with politics. 'As well might you expect to understand the politics of one European state without reference to the acts and laws of the others, as attempt to investigate the natural products of a colony without at least certain typical specimens from all other parts of the world'.[24] Such a collection was also essential to the provision of sound scientific education in the colony. In the long run this would strengthen the authority of younger local scientists who were disadvantaged by their limited access to education and museums in the northern hemisphere. Such authority and a good reference collection were also necessary if

Australia were to stem the flow of the most valuable material to overseas museums.

In pursuit of this reference collection McCoy immediately set about establishing a network of overseas collectors of high quality from whom to buy the specimens he required. The scope of his plans and the size of his budget are readily revealed by the first orders placed in 1857. Predictably one of the earliest went to John Gould (see Fleming *this issue*). He was asked to provide as large a collection of the generic types of 'good bird skins and for species as good [as] exemplification of the principal geographical groups' as £400 would purchase. The first consignment of 1,000 bird skins arrived the following year. These augmented the 150 North American bird skins presented by the Boston Society of Natural History in 1857 which included a pair of the now extinct Passenger Pigeon. Gould would ultimately provide ten thousand skins of birds and mammals (mostly from outside Australia) in regular consignments to the Museum until 1870.[25] J.O. Westwood was forwarded £250 to obtain 'as large a collection of generic types of insects, Crustacea and other articulata as can be obtained' accurately labelled according to the latest museum style. McCoy sought the efforts of Dr John Edward Gray, Keeper of Zoology at the British Museum, in obtaining examples of generic types and geographical groups of 'quadrupeds, British and other fishes dried flat, shells, corals, echinoderms and reptiles' to the value of £520. He was also asked to send a complete set of the British Museum catalogues. Rev. Professor Henslow of Hitcham Rectory, Suffolk was to see if he could acquire a 'copy as it were of your Museum of Economic, Botanical and Agricultural Museum at Kew'. All expenses of anyone undertaking to put this collection together would be 'cheerfully paid by the Colony whose desire it is above all things to save time or take it by the forelock'.[26]

McCoy's use of 'cheerfully' here is worth some reflection. It suggests a largesse and mood rarely associated with governments, certainly not hard-pressed colonial governments beset from every direction with urgent needs for basic infrastructure. Rather this is a transference of McCoy's own state of mind and heart. His pleasure in building Victoria's museum was immense, so immense that he could scarcely acknowledge that others might be less enthusiastic, that they might have other priorities for the spending of public money, or, in the case of collectors, that they would not mind waiting years to be paid for valuable consignments to the other side of the world.

Of these early contacts, John Gray proved a particular friend of the Museum. McCoy had not presumed to seek his personal attention, only that the 'tedious matter' of his requests be handed over to 'one of the zoological assistants', but Gray concerned himself closely with purchasing more than £3,182 worth of specimens between 1857 and 1864 when he suffered a debilitating stroke. He struck a bargain with Liverpool's Derby Museum which netted 128 mounted mammals and ten skins for less than the usual cost of stuffing alone, and spent six months attending to the mounting of 2,000 species of shells on boards and another three to name and catalogue an assortment of fish and reptiles preserved in alcohol. He offered to travel to Paris to evaluate 8,000 bird specimens offered by the Verreaux taxidermy firm and in 1863 purchased the Curtis British Insects Collection, which unaccountably had been turned down by the British Museum. Above all, Gray provided McCoy with essential introductions to professional natural history dealers and collectors in Britain and Europe where trade and commerce in such items was a flourishing business. He 'gave unstintingly of his time and talent to help the collections of a man he had never met and a museum he would never see.'[27] McCoy had managed in a remarkably short time to bring to Victoria a collection that embodied a good deal of the latest scientific understanding of the natural world.

In the first decade of his directorship McCoy enjoyed a relatively lavish budget. When this collection expenditure is added to normal running expenses and the cost of the new building opened in the grounds of the University in 1864, it amounted to over £80,000. In the new building he had far more scope to present the material according to his own view of the 'great chain of being' and the relationship between various animal groups. Here we return to consider a man who, even after half a lifetime's exile in the colonies, never relinquished a sense of himself as a scientist capable of generating and explicating new knowledge. His geographical museum layout became a concrete expression of his rejection of the new intellectual paradigms, not only Darwin's theories of natural selection and the origin of species by evolution, but the rise of biology, physiology and laboratory-based science that threatened the status of museums far more comprehensively than these theories. This steadfast rejection was in tune with many of his fellow citizens. The published tributes of the time tended more to praise him for this than ridicule. As one writer in 1881 declared, 'It is satisfactory in this age of weak-backed men to find someone who has the courage of his opinions'.[25]

That McCoy clung to older paradigms is hardly surprising given his age, but like others with more expertise than I can demonstrate, he seems to have rejected Darwin's theory in scientific terms, as he saw them (see Butcher *this issue*). It was not simply an irrational rejection of a novel idea. He did attempt to engage with the new theories 'as a scientist' and his Museum played a significant role in that engagement. A year before his death, McCoy drafted what appears to be a letter to a daily newspaper that was never sent - or at least, never published. In outlining his version of the history of the National Museum of Victoria, the ever increasing size of his handwriting and the intensity of the corrections and underlining underscores his rising passion. The story had acquired some revealing 'errors' of fact, and there was the unusual rehearsal of complaints about poor treatment and budgetary deficiencies, but far more interesting is his resonant, if querulous and long-winded, restatement of his philosophy of museum arrangement. It requires a long quotation to do justice to McCoy's propositions and his sense of himself as no mere imitator.

> The plan and arrangement of the National Museum had from the first some special peculiarities which have been since recognised generally as adding greatly to the interest of collections arranged according to the methods in the older museums; a little explanation may now be desirable.
>
> All the zoologists well acquainted with the great number of species are agreed that the Geographical Distribution of the Species is of a great & peculiar interest not striking the attention in the old museums. There are six ... regions of the earth, all the living creatures in which are so peculiar to one or other of them that the term 'centres of creation' has sometimes been applied to them by theorists. The fact is that very few creatures are common to any two of these regions, & in the design of our National Museum there was a separate gallery for each of these great regions of the world. This gives great interest to geographical studies, and the public will readily see the zoological peculiarities of each of these regions with a distinctness not suggested by any other arrangement. ... Each of the regions has a complete Systematic Classification of all the species in its own gallery. One can see by this plan at a glance the falsity of the view held by most theorists that the differences in the structure of animals are due to their surroundings, climate &c. One can see in our Museum when finished [McCoy had been waiting 34 years for the second wing to be built] that Australia, South Africa and South America present great tracts in the same latitudes, having practically the same surroundings in all their varieties, & yet ... the fauna of each is totally different from the other two scarcely a single species being in common & where in either of them the external circumstances would influence the habits, structure or appearance of some characteristic creature, instead of that species being common to the three similar localities they are '<u>represented</u>' by singularly similar creatures in habit and general appearance, but totally distinct structurally. The Ostrich of the sandy plains of Africa, for instance, is represented in the similar plains of Australia by the Emu; and by the Rhea in the similar plains of South America. In this way the 'theory of representative forms' comes with clearer apprehension to the visitor than in any other classification. In the three birds I mentioned there could be no question of one of these forms having grown out of the other by a difference of

surroundings, for the Ostrich has two toes, & the Australian and South American representatives three – a change not required, & all the three thriving when introduced into any one of the localities by man. The monotony in other museums of immense numbers of species of a genus showing little striking diverseness is curiously and suggestively relieved by breaking the series up into the great geographical regions or groups where the set in one country curiously represents the series in another. I believe that at present there is no known reason for those great characteristic geographical distributions and representations; but when the Museum is finished the visitors will have the means of judging for themselves on the truth of these theories, the facts, for the first time, being made clear in the initial arrangement; & children & travellers or persons studying the works of voyagers will have a peculiar pleasure in seeing all the characteristic animals of a country treated of, contrasted with those of another gallery ... [The fossil collection could also be used to reinforce his views] I have always considered the changes between the fossils of one geological formation and another comparable to the changes above referred to in the geology of the six great zoological regions of the earth at the present day. This is a new view, which I have had in mind in all the preparations of the Museum, & which will be clearly seen when the building is finished and my fine collections of fossils are displayed for inspection of the public in due systematic order; showing the world-wide distribution of species in the old time but distinctly conforming in the more recent [unclear] to the main characteristics of the geographical distribution of the living types ... of our own times.'[9]

McCoy had frequently stressed the singularity of his museum arrangement – not only because it was, in his view, more scientifically valid, but because it was more entertaining and engaging. He never conceived of his museum as one where display was not integral to its purpose. His supporters certainly praised the National Museum for the absence of the 'depressing monotony' seen elsewhere in Victoria 'where all the species of one genus are displayed together' and 'one has scores of cases of birds, avenues of skeletons, a mile of rats and mice' (though the modern reader might well wonder where these other museums actually were!) All that could be dismissed as yet further evidence of McCoy's famous dogmatism, which it certainly was from one perspective. On the other hand, it was the foundation of his strategy and the source of the drive that brought to colonial Melbourne a genuinely world-class, international collection. A more humble, self-effacing man would not have prevailed to the extent that McCoy did in overcoming the huge financial and other obstacles, most notably distance, that stood in the way of his ambition. A man less convinced of the near religious significance of the knowledge embodied in the collection and its arrangement would have scaled his vision to colonial horizons – and taken fewer risks with his money and his reputation. A man less convinced of the rightness of his vision and understanding would not have bothered to gather an international, representative collection, and Victoria would have been the poorer. A high priest in his cathedral of science for nearly half a century, McCoy created a museum that was the embodiment of his own singularity and Victorians then and now are the beneficiaries of that singularity.

Notes

[1] Scribe Books in association with Museum Victoria, November 2001.

[2] S. Sheets-Pyenson (1988). 'Cathedrals of Science: The Development of Colonial Natural History Museums During the Late Nineteenth Century', p. 25. (Magill-Queen's University Press: Kingston).

[3] Ibid., 25.

[4] Ibid., 26.

[5] Blainey, G. (1957). 'A Centenary History of the University of Melbourne', p. 14. (Melbourne University Press: Melbourne.)

[6] (1856). 'Museums in Victoria' in *Transactions of the Philosophical Institute of Victoria* 1, 131, 132.

[7] Pascoe, G. (1997). 'The University of Melbourne System Garden: Whose Garden? and Whose System?', p. 6. (BA Honours thesis, University of Melbourne.)

[8] R.J.W. Selleck, Manuscript of forthcoming History of the University of Melbourne from its foundation to World War II.

[9] See Piggot, A. and Strahan, R. (1979). 'Trustee-Ridden: 1860-74', *In* 'Rare and Curious Specimens: An Illustrated History of the Australian Museum: 1827-1979', pp. 27-36.

Eds R. Strahan *et al.* (Australian Museum: Sydney.)

[10] F. McCoy to R. Barry, 25 October 1856, McCoy Letter Book, 1. Museum Victoria Archives.

[11] McCoy could not have succeeded without the full co-operation of Surveyor-General Andrew Clarke. Indeed, a rueful Blandowski wrote to the *Argus* on 24 July 1856 to say that he had been ordered by the Commissioner of Crown Lands to pack the specimens for transmission to the University. See also Armstrong, E. La Trobe (1906). 'The Book of the Public Library, Museums and National Gallery of Victoria: 1856-1906', p. 28. (Trustees of the Public Library etc.: Melbourne.)

[12] *The Age* and the *Argus* generally supported those who opposed the move. See also, cartoon and verse in *Punch*, 14 August 1856; Sheets-Pyenson, *Cathedrals of Science*, p. 53. A. Moyal, *A Bright and Savage Land*. 1986 (1968; reprint, Ringwood: Penguin, 1993), 78.

[13] Memorandum by Professor McCoy on 'The Organisation of the National Museum of Melbourne', n.d. McCoy's papers, Museum Victoria Archives.

[14] McCoy, F. (1857). Museums in Victoria. *Transactions of the Philosophical Institute of Victoria* **1**, 127-128.

[15] *Argus*, 20 June 1865 and *The Illustrated Melbourne Post*, 25 July 1865. For an examination of this debate, see Butcher, B.W. (1988). Gorilla Warfare in Melbourne: Halford, Huxley and 'Man's Place in Nature'. *In* 'Australian Science in the Making', pp. 153-169. Ed. R.W. Home. (Cambridge University Press: Melbourne.) See also Butcher (*this issue*).

[16] See Sheets-Pyenson, *Cathedrals of Science*, p. 9.

[17] F. McCoy to A. Sedgwick, 14 December 1857, quoted Selleck, Draft Manuscript.

[18] R.T.M. Pescott (1954). 'Collections of a Century: The History of the First Hundred Years of the National Museum of Victoria', p. 36. (National Museum of Victoria: Melbourne.)

[19] Selleck, Draft Manuscript.

[20] Sheets-Pyenson, *Cathedrals of Science*, pp. 31 and 74; ibid.

[21] McCann, D. and Archbold, N. (*in press*). Frederick McCoy and the Conformation of the Global Geological Column. *In* 'Geology of Victoria', Third Edition. Ed. W.D. Birch. Note also Jackson, N.W. and Monaghan, N.T. (1994). Frederick McCoy, An Eminent Palaeontologist and his Synopses of Irish Palaeontology of 1844 and 1846. *Geology Today* 1994, pp. 231-234. See also McCann (*this issue*).

[22] Wilkinson, I. (1996). The first science professor at the University of Melbourne. *History of Education Review* **25**, 63-4.

[23] McCoy, F. (1859). *Transactions of the Philosophical Institute of Victoria* **6**, 7-8.

[24] McCoy, F. (1857). 'On the Foundations of Museum in Victoria', 4, 12. (Goodhugh and Hough: Melbourne.) See also, *Argus*, 29 May 1857 for text of this address.

[25] Pescott, *Collections of a Century*, p. 42. See also Fleming (*this issue*).

[26] Ibid., 35-36.

[27] Sheets-Pyenson, *Cathedrals of Science*, p. 76.

[28] 'Prominent Victorians', *The Leader Supplement*, 28 May 1881. See also *Table Talk*, 9 January 1891.

[29] Handwritten and considerably corrected manuscript in McCoy Papers. Blue Box of miscellaneous loose papers, Museum Victoria Archives.

'THE NATIONAL MUSEUM. - In 'The Book of the Public Library, Museums, and National Gallery of Victoria,' by Mr. E.L. Armstrong, M.A., LL.B., Chief Librarian, recently issued in connection with the jubilee of the foundation of the Melbourne Public Library, will be found some interesting notes of the early history of the National Museum ... Mr. Armstrong acknowledges [Professor McCoy] succeeded, in face of great difficulties, in making the Museum a credit to the colony and a fine memorial of its first Director; and, greatly as it has been improved since his death, the credit of collecting, determining, and describing a large portion of the contents will always belong to its first Director, whose knowledge of natural history was exceptionally wide, besides which he was the possessor of an extraordinarily keen memory.'

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Birds, Books and Money: McCoy's Correspondence with John Gould (1857-1876)

Anthea Fleming*

> Zoological museums are either local or general: the first being as complete a series of species as possible of some particular locality; the latter being principally generic types from all parts of the world (McCoy 1856).

Between 1857 and 1870, Professor Frederick McCoy, Director of National Museum of Victoria, acquired for its collection about 5,000 specimens of birds – mainly exotic – from Britain's pre-eminent ornithologist, John Gould, FRS. (This figure is based on the surviving lists and accounts in Museum correspondence. I believe the figure of 10,000 specimens, given by Pescott[2] and others, refers to *all* the specimens supplied by Gould, which included mammals, insects and shells.) Of these, 1,961 birds survive today, of which 561 are mounted, and 1,399 are study skins[3]. One thousand of Gould's skins were originally mounted for display.[4] Apparently some specimens were exchanged with other museums in Australia and elsewhere, but inevitably many fell victims to damage from dust, light and destructive insects.

The National Museum's correspondence files throw an interesting light on the development of the bird collections. Even before McCoy's time, 230 species of Victorian birds were represented[5] apparently donated from private collections. Many birds were – and still are – donated, often with a request for identification, such as the hawk, 'its plumage a beautiful pure white' [White Goshawk] sent by Andrew Anderson of Ballarat (19 February 1868), or the Regent Honeyeater sent by N. Mack from Warrnambool (15 September 1879). But McCoy intended that the Museum should become a general museum, capable of educating the students of the University of Melbourne and the general public about the natural history of all the geographic regions of the world. It was essential to obtain specimens from beyond Victoria and Australia. There were also many exchanges with overseas museums; McCoy was generous with Australian specimens, and often included a pair of Lyrebirds and some Bowerbirds in a shipment of 60 or 100 Victorian birds. Unfortunately only a few lists of what he obtained in this way seem to have survived. Other specimens came in from the Acclimatisation Society, and from collectors and dealers in Australia, New Zealand and beyond.

To obtain the birds for 'a good systematic Zoological Museum,' McCoy wrote to Gould in flattering terms, asking him 'to order ... as complete a set of good bird-skins as can be obtained, and for species [to exemplify] the principal geographic groups, ... for the sum of £400. (Australian specimens of course to be excluded.) ... *All should,* as a *sine qua non,* be named *fully*.' McCoy also ordered the *Supplement* to Gould's *Birds of Australia,* and in a post-script added 'We should particularly have all the strongly marked types – Flamingo, Hornbill, Toucan, Ostrich, Vulture etc.' (14 September 1857).

Gould replied promptly (7 December 1857). 'You shall certainly have a very fine series, as I have the means and believe I have the knowledge, particularly as to their fair value etc. ... You may expect a portion to be sent off to you in a month.' He also offered to obtain quadrupeds, insects, shells and other specimens if required and recommended his publications, such as the *Mammals of Australia,* emphasizing that they should be ordered '*from me direct*'. The publication of his lavish folio works was Gould's principal business and he saw Victoria as a profitable new market. Presumably the cost of Gould's folios and other authors' works led to McCoy's 1859 estimate that one thousand pounds was needed to provide the Museum with its 'books of reference for classification.'[6]

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The first consignment arrived in April 1858, packed in 4 tin-lined cases. It consisted of 1,021 birds, all individually named. Gould directed that they should be unpacked at once and stored in drawers or boxes, away from light and dust. In a fifth box, together with the two parts of the *Supplement* published to date, Gould sent samples of his publications: the *Toucans*, the *Partridges of America*, and sample parts of the *Hummingbirds* and the *Birds of Asia* (Letter, 25 January 1858). 'It will be impossible for you to ascertain the colours of the eyes and the soft parts of your birds when mounting them unless you have these publications.' (The Public Library duly accepted all these books on McCoy's recommendation.') A second shipment of about 400 birds, plus glass eyes for use in mounting the skins, arrived later that year. This had used up the £400, at an 'average cost per bird of just over 5s.6d each' (Gould, 20 May 1858). Gould complained that 'naming the species had been much more work than expected.' This was to be a perennial complaint. 'Many species are … not available at present. Please say if I should purchase desiderata and say what sum per annum etc. Rarer forms will be more expensive.' In a postscript he asked McCoy to obtain, by loan or purchase, 'one or two eggs of *Menura superba* to figure from', and in due course received one.

In reply to a letter from McCoy (not found, perhaps never entered in the Letter Book), Gould wrote (11 January 1859) that he had sent quadrupeds and birds from parts of Australia outside Victoria and NSW, besides some from Norfolk Island and New Zealand. He suggested that the Museum should have its own copy of the *Mammals of Australia*.

Business between McCoy and Gould settled down for some years into roughly annual shipments of birds, sometimes with nests and eggs and other specimens, and books. Payment was made via Victoria's Colonial Agent General in London. Gould (or his secretary Edwin Prince) drew up a financial statement at the end of each year, and Gould posted it next February.

Nineteenth century discoveries of new fauna in newly explored regions were one result of European exploration and colonial expansion. Alfred Russel Wallace's collections in the East Indies and New Guinea led him to recognize the abrupt boundary (now known as Wallace's Line) between the Oriental and the Australian zoogeographic Regions - which he discussed in 1859'. In April that year (14 April 1859) Gould enquired: 'Am I still to collect for you? Fine things from the Aru Islands and New Guinea collected by Mr Wallace fetched high prices - Birds of Paradise five pounds each, the dealers are now re-selling at a profit. May I spend £100 a year for you?' McCoy responded at once. On the 19 June, in a letter briefly summarized in the Letter Book, he gave instructions for the purchase of Wallace's Birds of Paradise. No price limit is mentioned in the summary in the Letter Book.

On 15 February 1860, Gould told McCoy: 'Large collections are now difficult; they contain what you already have.' In his next consignment (arrived April 1861) 'I have sent as much variety as possible, including females to match male Hummingbirds you have.' The only Wallace specimen mentioned was 'a splendid New Guinea swallow (*Dendrochelidon*)'. A pair of *Neomorpha* [Huias] from New Zealand - in high demand because of the different beaks of the two sexes - would now be priceless, as the species was extinct by 1910, probably through over-collecting.

In this letter, Gould showed himself up to the minute with current events, saying that a series of Common Pheasants *Phasianus colchicus*, including 'crosses' and white and pied birds, would 'illustrate Darwin's theory of artificial and "natural selection".' The *Origin of Species* had first appeared only on 22 November 1859. (McCoy's strong disapproval of Darwin's work on 'progressive development' is well-known.) Insects and birds' eggs were also sent. At this stage Gould had £143 in hand and suggested some high-priced birds – 'Surely your rich colony will not be behind the British Museum?' The temptations on offer included *Balaeniceps rex* (the Shoebill) at £20, a new Bird of Paradise *Semioptera wallacei* (Wallace's Standardwing) £14, the extinct *Nestor productus* (Norfolk Island Kaka) '*a large sum* - every year it will become dearer. Tell me if you have *Menura alberti* - I could send a pair. Let me know by return of post.'

McCoy repeated his request for Wallace's material (24 April 1860), apparently in forceful terms. Gould (22 February 1861) replied: 'Many of the birds now sent out were collected by Wallace. Your last note wishing me to *beg borrow* or *steal* anything sent home by him arrived after the present shipment had been forwarded: it matters little as I could not have procured you more … I am now not only out of funds but you are a little in my debt …' Such birds as female hummingbirds were difficult to name   a single bird might take an hour, even if he did not have to take it to the British Museum. 'I mention this to show I have some claim on you   if new species should be brought in … [they] should be sent to me to be figured in my publications… Please support my books…

'And now my friend, let me beg of you to write a little oftener … whether you get any new birds or quadrupeds …'

McCoy wrote (24 August 1862) asking again for more of Wallace's birds, and to say that, as Gould had requested, he was forwarding a pair of Victorian Lyrebirds, together with a Chestnut-crowned Babbler and a description and drawings of the Hairy-nosed Wombat from South Australia[9].

On 13 August 1862 Gould wrote to announce the despatch of two cases   500 fine birds in one, a few more birds and some books in the other. He promised another consignment later, but 'I must now tell you that I have for some time been without funds and you are in debt to me for some portion of the Birds and Books now sent, when convenient let me have a remittance …'.

McCoy's career as Director was a continuous series of financial struggles with Victorian Governments – he had no notion of confining his expenditure to what the government felt it could afford. In late 1861,[10] he agreed to 'observe the strictest economy … consistent with the efficiency of [the Museum].' From this time on, Gould was repeatedly irritated by McCoy's lateness with payments.

The expenses of construction of the new National Museum building in the University grounds led to a reduction in McCoy's annual grant, from £2,500 to £1,500 – though his pleas that he was committed to overseas purchases restored it to the larger sum[11].

The books would certainly have added to the debt, as they included a complete bound copy of the *Hummingbirds* and the *Toucans*, apparently sent on approval. But the large case of birds proved an unpleasant shock (25 October 1862):

'You will I am sure regret to hear … nearly half of [the birds] arrived so full of moth and living larvae that they could not be used and many of them had to be put into the fire at once. The *Colymbus septentrionalis* and *glacialis* [Loons] were the most complete mass of living larvae I ever saw and I think it was from them … that all the mischief came. The fine *Mycteria senegalensis* [Saddlebill Stork] was full of the larvae … many others were quite destroyed before their arrival. None of those you were kind enough to send before had the slightest thing the matter with them.

'I hope that by today's mail the Treasurer will send £100 to the order and next mail I hope to send some more. Pray send me … Wallace and everybody else's rare birds and also his Cuscus and other rare quadrupeds …'

McCoy had begun this letter with lavish plans to obtain skins of large quadrupeds – beginning with African and Indian Lions, Tiger, deer, bears etc. – to be mounted by the best English taxidermists. Perhaps those that died in English zoos and menageries might be obtained?

Gould (13 May 1863) gave this short shrift as 'not practicable'. Zoo specimens became mangy and emaciated, and in any case the British Museum had first call. The cost of shipping large mounted specimens would be unthinkable. His irritation was well-founded – the Victorian Treasurer had indeed sent him £100 in August, but no second payment had followed, and Gould was now owed £132 and a penny. 'How is this? You really cannot expect large collections to be transmitted if you do not send the means for their purchase.'

He complained that McCoy had not acknowledged the *Hummingbirds* – 'one really ought to be advised of such things. Pray do not become like most colonial men less punctual than you would have been in the "Old Country". Despite the debt, he was sending more birds – 138 specimens – 'Good things are now rare and difficult to obtain – *you have the cream*   still there are others procurable but you must send me the requisite funds.'

It seems surprising that Gould was prepared to continue to extend credit, even for a comparatively small consignment of birds. However he could not well break off the subscriptions to his costly books, which were his main source of income. Besides, he could not risk losing contact with those who might inform him of novelties or send him specimens.

Ninety-five pounds' worth of birds, and books, including the first two parts of *The Birds of Great Britain* (and some others intended for the Public Library), were sent off in April 1863, but again no remittance was made. On 19 September 1863 Gould wrote: 'Month after month rolls on and I do not receive either a letter or a remittance from you. I know the enervating character of your climate ... but you really ought to favor me with a line oftener ...' Sending the books for all Melbourne subscribers in the same case saved freight costs, but was a fruitful source of confusion as to which institution owed what sum. Subscribers to different works included the Public, University and Parliamentary Libraries.

McCoy's explanation of his current financial problems was written on 25 May 1864. First the 'unexpected expenses' brought about by books sent on approval had caused the cost over-run. Next, 'the Colonial Agent General had paid one of my correspondents about £500 more than I had authorized ... and your additional balance was then left unprovided for, although but for the books it had not arisen. By next mail ... I shall be able to send a remittance...' He complained in turn that the pair of Victorian Lyrebirds which he had sent had never been acknowledged, 'nor the drawings and description which I sent of the new South Australian [Hairy-nosed] Wombat.' From the Lyrebirds, Gould in 1862 had described[12] a new species *Menura victoriae*, (now reduced to a subspecies); it was named for the Queen, not the Colony.

McCoy was able to send £50 in June 1864; 'the remainder would go now, but for a difference of opinion in the Treasurer and Chief Secretary's office.' On 23 July he promised the remaining £32 'by the next mail', but seven months later it was still unpaid.

Gould wrote (24 February 1865): 'Your account has never been balanced since the commencement a spread of eight years.' He asked for the £32 plus another 17 guineas for books, totalling £49, seventeen shillings and a penny. 'I will then most readily go on and collect all I can for you.' Another case of books was on its way, but clearly there would be no more birds till matters were settled.

McCoy answered that he had already sent £50 in February (25 April 1865), and would have forwarded £25 more but for the breakdown of the mail steamer. 'I have sent to the Treasurer to request that £25 be forwarded ... We have scarcely any Psittacidae of India, Africa and America ... Paradise Birds would be very welcome ...' The £25 was sent in June 1865.

Gould (16 September 1865) was rather annoyed; the draft for £25 had arrived, but could not actually be cashed for another 60 days. But he was sending more birds and books, and announced the publication of his *Handbook to the Birds of Australia* – a summary of the text of his folio volumes. McCoy (24 November 1865) wrote that he would be 'most happy to subscribe to your new book ... and to sound its praise in all quarters'. In fact he had some criticisms, and when in 1869 he came to write a series of articles, under the pen-name Microzoon, in *The Australasian* on 'Our Colonial Birds'[13] (25 September 1869) he summarized them: the lack of measurements, (very useful for identification 'in the hand') and the lack of the 'generic characters', as many readers had no idea 'under what generic head to look'. His articles attempted to remedy this, covering raptors, owls, kingfishers and many passerines.

On 20 December 1865 Gould wrote: 'The £50 received ... in June at last overpaid your long overdue account to the close of 1864 by 2 shillings 11d. Since then I have received £25 and transmitted to you ... a collection of natural history ... to the amount of £65, plus books etc. makes the sum of £74 5s. Among the birds [is] ... an exceedingly rare Penguin *Aptenodytes forsteri* [Emperor Penguin], immature it is true but it is so rare a bird that I never had a specimen in my collection although I have several times offered £20 for an adult to some of the officers of Ross's Antarctic expedition.

'The Ladies, the Ladies, however have so stripped us of birds for their bonnets that but few are in the market and these of course are high-priced – still if it be your wish I shall go on collecting ... for you until you say *Stop.*' As well as the Emperor Penguin, this shipment included an Andean Condor and many parrots and woodpeckers, plus a few small North American mammals and eggs of about 19 species.

On 24 Aug 1866, Gould complained that McCoy had not yet informed him of its arrival, but offered: 'Some species collected by Wallace in islands north of Australia – not likely to be collected again (Fig. 1). Please say if required with balance of my last account, £49 5s. Let me know of any new discoveries [from] the interior for I am sure much remains to be discovered ...'

McCoy sent the money (26 October 1866), and was 'much obliged to you for putting by some of Wallace's birds ... You have left surprisingly little to be discovered in the bird way in Australia, but I shall be delighted of course to forward any novelties which may occur.'

The next shipment from Gould (26 March 1867) had been 'accumulating for an entire year - 620 species plus Naming took a month of my life. Duplicates cannot be avoided but where possible I have sent males or females where you had only the opposite sex ... you could exchange duplicates with other Australian museums.' The average price per bird was 5 s '[this] amounts to £155 which considering the great rise in the price of birds consequent on the present abominable fashion for the decoration of women's hats and bonnets, is exceedingly cheap; and I shall be obliged by your sending me a remittance ... as soon as you can.' This shipment contained no fewer than 50 specimens of birds collected by Wallace. Meanwhile, McCoy had published descriptions of two new species – the Rufous Bristlebird (Fig. 2) and the Yellow-rumped Pardalote *(Annals of Natural History,* 29 Dec 1866[14]) (Fig. 3). (For the controversy with E.P. Ramsay on the name of this Pardalote see K. Hindwood (1950)[15], *The Emu* **49,** 205.) Gould wished to borrow the specimens for the *Supplement.*

Fig. 1. Double-eyed Fig-parrot *Cyclopsitta diophthalma* collected by Alfred Russel Wallace from New Guinea and Mysol Island. Photo by Anne Morton; from the Museum Victoria collection.

'I am even more especially interested with the *Casuarius australis* vel *C. johnsoni* Mueller. Now no-one better than you knows the importance of publishing a good figure ... there are several species of the group ... of which it is impossible to point out the distinctions without an actual comparison, and surely I am the person in Europe who ought to do this.'

Gould's interest had been roused by Ferdinand von Mueller's description of the first specimen of the Australian Cassowary in the *Illustrated Sydney News* (29 December 1866)[16]. The species had been known since the disastrous Kennedy Expedition of 1848, but that specimen had been lost. Mueller named his bird *C. johnsonii* after its collector, and after a detailed description of differences with the well-known East Indian Cassowary wrote:

Fig. 2. Rufous Bristlebird *Sphenura broadbenti* as described by Frederick McCoy (now *Dasyornis broadbenti*). Photo by Anne Morton; from the Museum Victoria collection.

'Further discrepancies … will unquestionably be pointed out by our learned professor of natural history whenever the solitary specimen, which I intend to present to the Melbourne Zoological Museum, shall have arrived.' But the specimen never appeared. McCoy later suggested to Gould that it had been 'intercepted' (4 February 1868). In a Microzoon article[17] (4 September 1869) McCoy described a young Cassowary 'about two feet long' which had been 'very recently' supplied by Mueller, and compared it with a Cassowary from Ceram of the same size. For this young Australian Cassowary, incidentally, McCoy exchanged a collection of 20 rare Victorian mammal specimens[18], including skins of the Eastern Hare-wallaby *Lagorchestes leporoides* and the White-tipped Sticknest Rat *Hapalotis apicalis* – both now extinct. Mueller also provided a 'portion of the skin of the adult Cassowary'[19] and received in return 'two dozen Victorian birds not found near Melbourne, and one the Red-capped Pomatorhinus [Babbler] only described a few years ago, as a slight exchange for the *Casuarius* with which you enriched the Museum' (26 June 1869).[20]

On 26 June 1867, McCoy sent the Pardalote and Bristlebird to Gould on loan. On 26 September (a letter omitted from Letter Book), he forwarded two specimens of what he believed to be a new Honeyeater *Ptilotis leadbeateri* (Helmeted Honeyeater), named after his able assistant. Gould was dismissive – 'a bird … long since named *P. cassidix* by Jardine … I have figured it in the new part of my *Supplement*.' (20 November 1867). In fact McCoy's description was published in the *Annals* on the same day as Gould's in the *Supplement*, 1 December 1867; Jardine's name, as used by Gould, became accepted because it was accompanied by an illustration[21] (Part 2, Plate 6).

Gould thanked McCoy for the loan of the specimens, and said that in the forthcoming part of the *Supplement* he had acknowledged 'McCoy and his Directors' liberality.' He concluded: 'You write and spur me on to collect and send birds to your Museum but you seldom acknowledge their arrival and are somewhat tardy in remitting the money I may have expended for you.' The balance due was £164 10 s – no small sum.

McCoy (4 February 1868) promptly pointed out 'Pray understand that I am the only Director of the Museum of Natural Science here. I have the exclusive management of it as a head of department.' He was disappointed about the Honeyeater (in a Microzoon article[22] McCoy later disputed Jardine's priority and kept the name honoring Leadbeater). 'I beg of you to believe that I have not overlooked the remittance due to you of the £164/10/- through carelessness, but owing to political contest, no payments have been made for 4 or 5 months and cannot probably for two months more – at the same time there is no cause for uneasiness as the Treasury is full of money and all parties willing to pay when political contention is at an end.'

On this occasion the delay in payment was not McCoy's fault. 'During 1867 … Supply was refused to the Government of the day and money was not available for any of its normal functions.'[23] Moreover, McCoy's grant was reduced by 30% and he was ordered not to incur any further liabilities without the approval of the Chief Secretary.[24]

Gould wrote, announcing another shipment and again requesting this payment on 18 February 1868. He wrote once more on 8 April 1868: 'It is desirable that these accounts should be settled as early as may be, besides which I really want the money.

Fig. 3. Yellow-rumped Pardalote *Pardalotus xanthopyge* described by Frederick McCoy (now Spotted Pardalote *Pardalotus punctatus xanthopyge*). Photo by Anne Morton; from the Museum Victoria collection.

I have put away for you several interesting objects …

'I am sorry you have not yet received the cassowary … I hear there is a specimen en route to London; if so I hope to get a drawing of it.'

On 24 April 1868, McCoy wrote: 'I hoped to have been able to send the remittance by this mail, but although the Treasury is full of money, the contest still remains between the two houses of Parliament – but I hope to be able to send it by the next mail.'

Gould, writing to say that at last he had an Australian Cassowary to draw (19 June 1868), added 'I hope you will send me the money next month.' A fifth part of the *Supplement* was planned 'Pray forward me for figuring any other new birds you may have,' such as Ramsay's new *Orthonyx* (*O. spaldingii*, the Chowchilla).

McCoy, 19 June 1868: 'I exceedingly regret not being able to send you the money by this mail, owing to the political contest between the two houses of Parliament, but shall not fail to do so as soon as the money is available.'

At last on 14 August 1868 McCoy could write: 'I have the pleasure of informing you that by the present mail £115 is forwarded to your credit … the balance I will send by the next mail. Many thanks for your kindness in selecting the additional species for the Museum, which I long very much to receive as I have not seen a bird from you for a long time.' He was able to forward another £63 1s. on 12 October.

On 2 Feb 1869, Gould wrote to tell McCoy that he was sending a case with 530 birds, plus eggs of 15 Indian species. The total cost would be £132 10s. The average cost was between 4 and 5 shillings, though some cost very much more. They included the very rare '*Didunculus strigirostris* believed by many to be allied to the Dodo. I have been blamed for letting it pass out of Europe. [It] should be well cleaned and mounted and if your taxidermist is a clever hand at his profession, he will make it … even better than the one in the British Museum.' [This was the Samoan Tooth-billed Pigeon, now believed to be extinct]. For the future, Gould promised interesting birds from Bogota and a pair of the cave-dwelling Guacharo or Oilbird, *Steatornis caripensis*. 'These will be sent at the close of the present year, unless I hear from you that I must *stop* or that your funds will not allow you to continue.'

This case was duly sent in December 1869, but McCoy did not write to Gould. On the 18 February 1870, Gould wrote:

'Twelve months barring six days have elapsed since I last wrote to you stating that I had a case of Birds and Books for you in the *Yorkshire* and requested to be favored with an answer … On reflection I am sure you will say 'this is too bad!' Your silence really prevents me from acting for you … and is the reason of my sending out … only a small series of birds and a few eggs – only 34 specimens of 22 species.' He also included the parts of the *Birds of Great Britain*, *The Trogons*, and part 5 of the *Supplement*. 'Besides writing to me I must really ask you for a remittance: your Bill enclosed shows that you owe me £112 14s.'

A major change had occurred. The Government had passed an Act of Parliament (29 December 1869), to provide for 'the incorporation and government of the Public Library, Museums and National Gallery of Victoria.'[25] Fifteen trustees were appointed (4 February 1870), who were given power to make rules and regulations for the corporation. McCoy had irrevocably lost his independence. In his rearguard struggles to protect the Museum he had built up, he had no time to write to Gould. Many of his orders for overseas material had to be cancelled at this period. Moreover, in 1871, changes to the Museum's finances meant that many payments, including salaries, were delayed for months because such business now had to go, via innumerable official forms, through the President of the Trustees.[26]

Gould wrote (25 February 1871) 'As I have not received a reply to my Letter ... of Feb 12. 1869 nor to that of Feb 18, 1870, I am naturally very desirous of knowing the reason of your silence ... What can be the cause of your not replying? Our correspondence is mainly in your interest and I do think that on reflection you will come to the conclusion that you are not using me well ... The debt of your Museum is increasing ... it now owes me £119 ...

'I shall not in this allude to the subject in which we are both interested – natural history – but am ready to enter upon it when I again hear from you.'

At last McCoy replied: (c. 18 May 1871): 'The delay in settling your account and in writing to you arises from the unsettling the affairs of the Museum by the appointment of Trustees for it and several allied institutions who so reduced and impeded all money transactions that I must beg you to forward nothing more until I am able to place your money in your hands. I have made an application to have your £119 paid forthwith, but cannot be certain when it will be forwarded as yet. I shall stop all expenditure for the present until matters are more settled.' In June, McCoy apologized for further delay – Gould's bill must be sent in the form requested by the trustees.

On 25 October 1871, Gould replied: 'In your letter ... you say that the change in your Ministry has delayed the remittances due to me ... I have received no money from you since the early part of 1869 and therefore I hope the Trustees will take my claim of £119 into consideration ...

'I particularly regret that the action of the Trustees has prevented you from continuing your collection as you have thereby lost many very fine things from New Guinea and the neighbouring islands ... you I know will also regret this. To be cramped in your endeavours to raise a large and fine collection for the Colony must be very disheartening.

'A short time since I delivered to Mr Bain of the Haymarket London the two parts of the *Birds of Great Britain* due to your Museum and they will be duly delivered to you by his correspondent in Melbourne on their arrival.' Apparently Gould had handed over the distribution of his books to Bain. The bill is annotated: Paid by mail 21/12/71.

McCoy wrote on 27 December that year, apparently believing that all was well, now that the bill had been paid: 'Pray keep at least 25 pounds' worth of desiderata for us a year until good times come again,' and again in 15 July 1873: 'I forward by the mail £20 on a/c of books etc. and hope to hear you will continue your kind vigilance for new or rare species not formerly sent, as the tremendous dislocation produced by putting the Museum in connection with a body of Trustees is settling down more near its good old way.' But apparently Gould did not respond to this suggestion.

Gould's last letter (15 April 1876) refers to a shipment of books forwarded by Mr Bain. It shows clearly that he could no longer disguise his exasperation with disorganized subscribers.

'Kindly say for Heavens' sake to whom the case should be shipped and to which library *New Guinea* should be sent. This confusion sadly perplexes me and makes me say I will never send another book to Melbourne ... Let your secretary find to which Institution the other books should be forwarded to, if possible by return of post and you shall have the continuation of *New Guinea*. Pt 3 is ready containing some marvellously beautiful things; this and some fine birds shall at once be sent when I hear from you.

'This New Guinea is a wonderful country teeming with novelties, novelties which bear so much upon Australia as to render it of great interest to you.

'Pray then get me out of this mess with regard to names and payments of your Melbourne Institutions, and you shall have all early information on the subject.'

McCoy could no longer order birds without the Trustees' approval, so it seems nothing came of this last offer on Gould's part. Gould's signature now looks very shaky, unlike his former confident bold hand: it clearly shows that he was already affected by ill-health. Gould was by now 71 years old; he was to die five years later on 3 February 1881. Professor McCoy was to continue as Director of the Museum, despite all difficulties, until his own death in 1899.

N.B. No attempt has been made to modernise obsolete scientific names. Where possible, common names have been inserted.

All correspondence quoted is held in the Library of Museum Victoria. The inward letters of Gould and others are quoted from the originals. McCoy's letters are taken from the Museum's Letter Books – unfortunately, often only a brief summary is recorded, and some letters were never recorded at all. Gould methodically quotes dates of letters received from McCoy, so some gaps can be identified.

Gould's letters, 30 in all, with accounts and lists of specimens supplied, are generally in good condition, though some thin paper is becoming brittle. Some letters, originally posted without envelopes, have suffered tearing, with loss of some text, when their stamps were removed by some unknown stamp collector.

Acknowledgements
My sincere thanks are due to Frank Job, Wayne Longmore and Alan Yen of Museum Victoria, to Doug McCann who kindly supplied copies of McCoy's 'Microzoon' articles, to Merilyn Grey and Anne Morton of FNCV, and to my husband and son for technical assistance. Finally, I must remember the encouragement given by the late Allen McEvey to my early interest in Gould and his works.

Notes

[1] Pescott (1954), *Collections of a century*, 28.
[2] Pescott (1954), 42.
[3] Wayne Longmore, *pers. comm.*
[4] Pescott (1954), 42.
[5] Pescott (1954), 7.
[6] Pescott (1954), 44.
[7] A. Tulk, Librarian, Museum Victoria correspondence, 13 May 1858.
[8] Wallace (1859).
[9] Datta (1997), 432.
[10] Pescott (1954), 47.
[11] Pescott (1954), 53.
[12] *Proceedings of the Zoological Society of London*, 1862, 23, cited by Whittell (1954), 295.
[13] Microzoon (McCoy) *Australasian*, September 25 1869, 390-391.
[14] Cited by Whittell (1954), 461.
[15] Hindwood (1950).
[16] F. von Mueller (1866).
[17] 'Microzoon' (McCoy) (1869a).
[18] McCoy, letter to F. von Mueller, 9 February, 1869, Museum of Victoria correspondence.
[19] McCoy, letter to F. von Mueller, 28 May 1869.
[20] McCoy, letter to F. von Mueller, 26 June 1869.
[21] Mathews (1923), 'Birds of Australia', vol. 11, 504.
[22] 'Microzoon' (McCoy) (1870).
[23] Pescott (1954), 65.
[24] Pescott (1954), 88.
[25] Pescott (1954), 69.
[26] Pescott (1954), 74.

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McCoy and Clarke: their Dispute Over the Age of Australia's Black Coal

Roger Pierson[1]

Abstract
From 1847 until his death in 1899, Professor Frederick McCoy, palaeontologist in Melbourne, maintained a war of words in the scientific literature with Rev. William Clarke, geologist in Sydney, concerning the age of Australia's black coal deposits. McCoy was convinced that the coals were all of Mesozoic age and Clarke, during the period from 1847 to his death in 1878, maintained equally vehemently that they were Palaeozoic. In fact, Clarke was correct in placing the New South Wales coals in the Palaeozoic, and McCoy's placing of the Victorian coals in the Mesozoic was also correct. The two men were both particularly stubborn and neither would admit that they might have been arguing about coals of differing ages. Both stood unbendingly by their Northern Hemisphere, European backgrounds, and neither would change their views in the face of new evidence from the Colonies. (*The Victorian Naturalist* **118** (5), 2001, 219-225.)

For over 30 years from the middle of the 19th century, Frederick McCoy and William Branwhite Clarke conducted wordy battles in the scientific literature over a matter dear to both their hearts: the age of Australia's black coal beds. McCoy argued from Melbourne for a Mesozoic age, while Clarke in Sydney argued equally strongly for a Palaeozoic age for the coals. It is interesting to note that although Clarke maintained his belief in a Palaeozoic coal age for most of his time in Australia, he argued for an Oolitic age in 1841 (Jervis 1944; Vallance 1975; Vallance 1981). The Oolitic (or oolitic as it was commonly written) of the 1840s was approximately equivalent to the Jurassic Period of the Mesozoic Era in modern terminology. Explaining the prevailing view on coal held in the mid-1800s, Stafford (1989) wrote, 'Since Carboniferous coals were considered of higher value as steam fuel, this stratigraphic battle had direct implications for colonial development'. As well as a clash of intellects between McCoy and Clarke, there was an underlying commercial pressure on them to assert that the New South Wales coals were Palaeozoic in age. The Palaeozoic 'Carboniferous' age of the time was that proposed by Conybeare and Phillips in 1822 (Secord 1986). It spanned what are now accepted as the Carboniferous and Permian Periods.

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Frederick McCoy's early life is covered elsewhere in this volume. William Clarke was born in East Suffolk, England in 1798 (Grainger 1982). His formal education was completed at Cambridge University where one of his tutors was Rev. Adam Sedgwick, Woodwardian Professor of Geology. Clarke obtained his BA degree in 1821 and his MA in 1823, and he was ordained in the same year. He was accepted as a Fellow of the Geological Society of London in 1826 (Mozley 1969). Clarke combined his curate's duties with poetry writing and the practice of geology. In 1828 his presumed first geological publication, in the *Magazine of Natural History*, described how he replaced a wooden handle on his geological hammer with 'an elastic handle of leather' (see Grainger 1982). Following severe attacks of rheumatism, he received medical advice that he should live permanently in a warm climate. This advice, together with his curiosity concerning the unknown geology of the colonies, led Clarke to emigrate to New South Wales with his family in 1839 to take up a chaplaincy.

Clarke continued geologising and collecting around New South Wales as he undertook his church ministry, just as had been his practice in England. He sent several boxes of fossils from New South Wales to Professor Sedgwick at the Woodwardian Museum in 1844, for classification. Sedgwick did not consider himself a palaeontologist and the fossils remained unclassified until 1847 when Frederick

McCoy, at that time working as Sedgwick's assistant, was given the task. The geological paths of McCoy and Clarke crossed for the first time.

McCoy (M'Coy 1847) soon published the results of his classification of the fossils. He recognised 'abundant fossil remains of animals referable to the palaeozoic period', and above these 'a series of clays, shales and sandstones, with remains of fossil plants and beds of coal'. The genus *Glossopteris* (Fig. 1) was one of the most common plant fossils that he recognised, and he argued that it was 'never found in the old-coal fields, but well known in coal-beds of the oolitic age in various parts of the world'. *Glossopteris* had been described and named by Brongniart in 1828 in material collected from the Newcastle Coal Measures in New South Wales by Robert Brown, Matthew Flinders' botanist, in 1801 or 1802 (see Brown 1946; Murray 1983; Vallance 1975). *Glossopteris* was found in coal from India as well as from Australia by Brongniart, but was quite unknown in the European coal measures (Vallance 1975).

One of the new plant fossils named by McCoy was *Cyclopteris? angustifolia*, a species that received more of his attention in later years. At the 17th *Meeting of the British Association for the Advancement of Science* in 1847, he discussed Clarke's 'oolitic' plant fossils and stated that no trace existed of 'any characteristic fossil of the old coal of Europe or America' (M'Coy 1848). These 'old coals' were considered to be of Carboniferous age.

Convicts first found coal on the coast north of Sydney in 1791. George Bass, the explorer, had observed coal cropping out along the coastal cliffs as he sailed both northwards and southwards from Sydney during 1797 (Vallance 1975). Bass speculated upon the possibility of a coal basin in the region. At that time, 'Lithological stratigraphy still prevailed and insofar as anyone cared about Australian coal it was assumed to match European (Carboniferous) coal' (Vallance 1981).

The accumulation of knowledge relating to the age of Australian coal has been documented by Archbold (1985), Branagan (1998), Brown (1946), Murray (1983), and Vallance (1975, 1978, 1981). Prominent participants in this gathering of knowledge were T.L. Mitchell, P.E. de Strzelecki, J.D. Dana, J.B. Jukes, W.S. Macleay, F.W.L. Leichhardt, A.R.C. Selwyn, R. Daintree, and of course McCoy and Clarke. Opinions expressed varied as to the age of the coals and as to whether or not the coal plant fossils were conformable with associated marine invertebrate fossils.

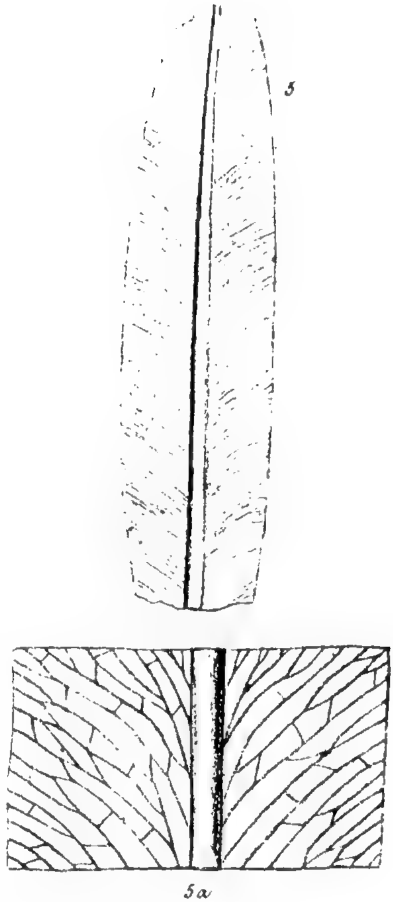

Fig. 1. *Glossopteris linearis* (M'Coy) from M'Coy (1847) Plate 9: 5 and 5a.

McCoy's 1847 paper classifying Clarke's fossils (M'Coy 1847) polarized the geological community when he confidently argued for a Mesozoic age for Australian black coals. By 1847, Clarke had moved on from his 1841 belief that the coals were Oolitic. Based upon fossil evidence, J.B. Jukes, in 1842, had decided that 'Australian coal was at least as old, and probably older than, the Carboniferous coal of England' (see Vallance 1981). Clarke adopted this position and maintained it for the remainder of his life. Since McCoy and Clarke were prominent proponents of the ensuing Mesozoic/Palaeozoic coal age furore in Australia, their publicly aired differences dominate this paper.

In 1848, Clarke had sent a specimen to Sedgwick that bore impressions of *Glossopteris* along with marine invertebrate remains (Vallance 1981). This was evidence of the co-existence of a plant fossil that McCoy was convinced was Mesozoic with Carboniferous invertebrate fossils. McCoy remained silent, and amazingly Clarke did not press the issue.

McCoy was chosen as the first Professor of Natural History of the University of Melbourne when it opened in 1855. His arguments with Clarke gathered momentum.

In 1860, the Governor of Victoria and President of the Royal Society of Victoria, Sir Henry Barkly (1861) reported to a Royal Society of Victoria meeting that specimens of the fossil plant genus *Taeniopteris*, discovered in coal beds at Cape Paterson, had been exhibited at the meeting by Professor McCoy. McCoy had told the meeting of Clarke's claim that an absence of *Taeniopteris* in Australian coals indicated that they could not be of Oolitic age. With this new species, *Taeniopteris daintreei*, McCoy felt he had strengthened his Mesozoic age position for the coal and refuted Clarke's claim (Fig. 2). (In fact, the coals at Cape Paterson are Mesozoic, and McCoy was correct in his assumption of that age based upon the fossil *Taeniopteris daintreei*.)

Clarke (1861a) was quick to respond to McCoy's assertions and wrote that, '*Taeniopteris* and *Glossopteris* (*Sagenopteris*) have been the means of placing, by some geologists, the coal deposits of Australia and India in the horizon of the oolitic coal'. He pointed out that the genus *Taeniopteris* may range from Carboniferous to Tertiary and that the age was determined by the species. Clarke then returned to McCoy's original classification of his fossils in 1847. He wrote, 'Mr McCoy, who knew nothing of Australian plants' had 'because of the absence of certain genera, and the presence of others which have a relation to some oolitic species' assumed an Oolitic age for the fossils he had sent to Sedgwick in 1844. Clarke maintained, in this paper, that the coal beds were Carboniferous.

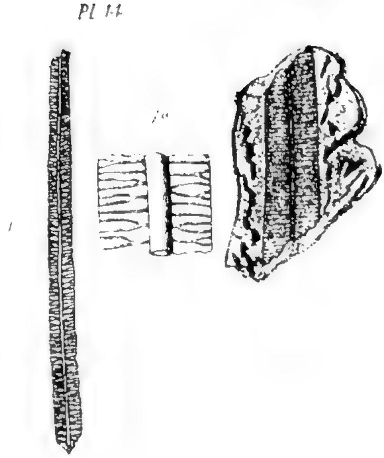

Fig. 2. *Taeniopteris daintreei* (McCoy) from McCoy (1875) Plate 14: 1, 1a and 2.

McCoy (1861a) immediately took exception to Clarke's comments. He stated 'that the time of a scientific man may be better employed in endeavouring to add new facts to the general store of human knowledge than in defending himself or his views...'. But in this case he felt he had to respond, and in doing so he dissected Clarke's paper paragraph by paragraph, fighting for acceptance of his own age interpretation and strongly dismissing Clarke's Palaeozoic age for the plant fossils. McCoy accused Clarke of misrepresenting the source of a specimen of *Lepidodendron* found by 'an unscientific friend' from Queensland. In this paper, McCoy named a new genus, *Gangamopteris*, through a specimen he called *Gangamopteris angustifolia* (Fig. 3). The example was from Bacchus Marsh sandstone. He stated that he had previously figured it from the New South Wales coal beds under the name of *Cyclopteris? angustifolia* in 1847. He inferred its age to be Mesozoic because of its association with *Glossopteris*.

In his turn, Clarke (1861b) responded to McCoy's dissection of his paper. He stated that he was 'not aware, till I perused

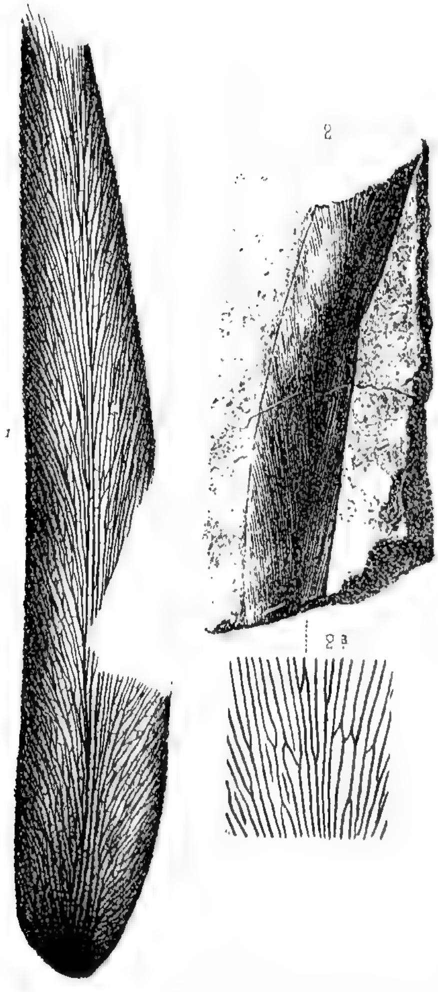

Fig. 3. *Gangamopteris angustifolia* (McCoy) from McCoy (1875) Plate 12; 1: Plate 13; 2 and 2a.

Professor McCoy's "Commentary" on my letter, that I had offered any grounds of offence in it'. He took McCoy's paper apart, again paragraph by paragraph, and proceeded to justify his belief that Australia's coal bearing rocks were Carboniferous. On the question of the *Lepidodendron*, he corrected McCoy and stated that 'the late Dr Leichhardt, an excellent geologist', had recognised the fossil in New South Wales. The ill will between the two men was evident in almost every sentence of their papers, despite Clarke writing 'I have no object in any controversy on this question but truth'.

The bickering continued when McCoy (1861b) informed the reader of the 'real point at issue, namely:- Mr Clarke holds and has always held that the "*Glossopteris* beds" associated with the coal of New South Wales are Palaeozoic, and belong to the same geological epoch as the underlying marine beds containing Lower Carboniferous animal remains. I hold and have always held that the aforesaid "*Glossopteris* beds" are Mesozoic'.

In a paper read to the Royal Society of Victoria in 1861 but not published until 1865, Clarke (1865a) argued at length for a Palaeozoic age to be assigned to the coal beds of the Maitland district of New South Wales. He maintained that he had located beds 'containing fossils of the same Palaeozoic formation which Professor M'Coy has long ago determined to be at the base of the "Lower Carboniferous" formation of Ireland' at Maitland.

In the same year Clarke (1865b) continued to press his opinion against McCoy's Oolitic age for the New South Wales coals. He wrote, 'the vegetable fossils, which are taken as the datum for the Oolitic age of the coal, have been traced into a position between rocks assigned, from their distinctive zoological fossils, to be as low as the "base" of the old "Carboniferous system"'. He defended his stance in relation to the existence of Mesozoic formations in Australia by stating that, 'the existence of Mesozoic formations has not been disputed by me; all that my position amounts to is the denial that the coal beds of New South Wales are Oolitic'. Clarke (1861c; 1861d), described *Glossopteris* and *Cyclopteris* in shale at Maitland lying **beneath** beds containing Palaeozoic marine fossils, reinforcing again his Palaeozoic age for the associated coal.

The Australian geological community must have been getting thoroughly tired of the sparring between McCoy and Clarke that was interminably ongoing through the respected journal of the Royal Society of Victoria. In reality the two individuals allowed their respectively entrenched positions to outweigh their intellects. McCoy and Clarke met on at least one occasion. Clarke (1861a) wrote that he had personally shown McCoy plant fossils that he had taken to Melbourne. Taking into account the obvious hostility they showed towards each other in their writing, it would be interesting to know how McCoy and Clarke reacted towards one another at this meeting. Vallance (1978) felt that both McCoy and Clarke were 'locked in a cell of European experience', and that 'McCoy remained a British palaeontologist in Australia, just as Clarke continued to be a British geologist'.

In another paper read to the Royal Society of Victoria in 1861 and unpublished until 1865, McCoy (M'Coy 1865a) reported on the age of fossils collected at Wollumbilla, on the Fitzroy Downs of Western Australia, and sent to him by Clarke. (Despite the animosity between the two, Clarke continued to rely on McCoy's palaeontological skills.) McCoy stated that, for the first time in Australia, he had found a Mesozoic marine fauna, including ammonites and belemnites in this collection. He felt that the marine deposit was of exactly the same age as the eastern coal beds; 'to the base of the Mesozoic series, certainly not lower than the Trias, and not higher, I think, than the lower part of the great Oolite'.

At his Presidential Anniversary Address to the Royal Society of Victoria in 1864, McCoy (M'Coy 1865b) noted that Richard Daintree had 'tried to settle the points in dispute between Rev. Mr. Clarke and myself, relative to the age and position of the beds associated with the coal of New South Wales, but failed'. Richard Daintree (1864a; 1864b) had, in fact, detailed at length his belief in Clarke's observation of *Glossopteris* in shales and coal below the marine Carboniferous beds at Stony Creek, near Maitland. Daintree (1864c) repeated his support of Clarke's position in a brief abstract printed in the *Bulletin de la Société Géologique de France*. Interestingly, this abstract figured a measured stratigraphical section at Maitland, clearly showing *Glossopteris* beds below the then undisputedly Carboniferous marine beds. It is difficult to understand how McCoy interpreted Daintree's reports as having failed to 'settle points in dispute'. In 1864, William Keene (1865), Examiner of Coal-fields, New South Wales, reported that '... *Glossopteris* accompanies the entire series of Coal-measures from the topmost to the lowest seam'. He stated that his specimens 'will prove satisfactorily that the coal-seams of New South Wales belong to as old a geological series as those of Europe'. (His statement did not prove to be correct.)

McCoy (1867) took his Mesozoic coal age argument to the Americans with a paper in *The American Journal of Science and Arts*. In the same year, he (M'Coy 1867) published his belief in the age of Australia's coals in the *Annals and Magazine of Natural History* in England; he had published his descriptions of Clarke's original fossils in this journal in 1847. He referred to species of *Zamites* and *Taeniopteris* recognised from Cape Paterson and Bellarine, *Glossopteris* and Belemnites and Ammonites from New South Wales, and *Gangamopteris* from Victoria and New South Wales, as positive proof for a Mesozoic coal age.

Clarke (1868) also published in *The American Journal of Science and Arts*. Referring to the New South Wales coal seams, he stated, 'Up to a comparatively recent period, it was not known that under the marine beds below these coal seams, other seams occur bearing the same genera of plants as in the upper beds'. Daintree, he maintained, had verified this fact.

In his *Prodromus of the Palaeontology of Victoria*, McCoy (1875) described and provided plates of Victorian examples of three species of *Gangamopteris* from Bacchus Marsh and one of *Taeniopteris* from Cape Paterson. He maintained that their age was Mesozoic. The plates and descriptions for the *Prodromus* had been prepared in the 1860s, but publication was delayed due to a lack of government funding until 1875.

In his *Report on Palaeontology of the Geological Survey for the year 1891*, McCoy (1892) described a fragment of *Schizoneura*, 'from a newly discovered bed just under the famous *Gangamopteris* sandstone of Bacchus Marsh'. This fossil, he wrote, indicated a Mesozoic (Triassic) age for the bed. Although the precise location of the supposed Triassic bed was not given, and McCoy mistakenly placed it **below** the *Gangamopteris* beds, the *Schizoneura* was probably discovered in what is now known as the Council Trench Triassic outcrop at Tramway Lane, Bacchus Marsh. The outcrop is stratigraphically **above** the *Gangamopteris* sandstone. McCoy (1898) reported the finding of *Taeniopteris sweeti* in 1897 at Bacchus Marsh in the same sandstone beds as *Gangamopteris angustifolia* and found it 'of value as indicating a Mesozoic age for this Victorian rock'.

Clarke had died, aged 80 years, in 1878. In that year he (Clarke 1878) published the fourth edition of his book *Remarks on the Sedimentary Formations of New South Wales* in which he remained adamant that the New South Wales coal beds were of Palaeozoic age.

From 1847, to his death in 1899, Frederick McCoy always maintained that the plant fossils found in Australian black coal beds and identical fossils found in other, non coal-containing beds, clearly and unerringly indicated that the coal and sediments were all of Mesozoic age. He stubbornly refused to bend in the hope that he would ultimately be proved correct.

In presenting a lecture on early Australian geologists, Professor E. Skeats (1933) wrote of McCoy stating, 'He was, in fact, a distinguished palaeontologist, rather than a geologist. There is, I believe, no record of his ever having undertaken fieldwork'. This is generally true of McCoy's time in Australia; he had, however, carried out geological field survey work in Ireland in the 1840s (Anon 1899; Anon 1900) and with Adam Sedgwick in Wales in the early 1850s (Secord 1986). Clarke's geological work, in contrast, was based upon numerous collecting journeys to the field and upon his observations made there. Perhaps it was inevitable that two men with such differing approaches to their science should have vigorously defended such opposing views on the age of Australia's coal beds.

As Darragh (1992) reasoned, 'Neither McCoy nor Clarke realised that they were arguing about two different series of rocks of widely different ages. In the end McCoy was right about the Mesozoic age of the Victorian coal bearing rocks, and Clarke was right to regard those of New South Wales as Palaeozoic. Both scientists did not come out of this controversy very well, because neither was prepared to accept the new evidence of the other but argued from a predetermined position based on outdated data'.

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Frederick McCoy's Anti-evolutionism – the Cultural Context of Scientific Belief

Barry W. Butcher[1]

June 1865 and excited Melbournians are flocking to the National Museum of Victoria to see the latest arrival, a gorilla, the first (albeit stuffed) to arrive in the Antipodes. Centrepiece of a glass-encased 'family' of great apes, it represents the successful culmination of the Museum Director's three-year effort to acquire a specimen of this the largest and most recently 'discovered' of the anthropoids (Butcher 1988; Fig. 1). Nearly a century and a half later we can only speculate on the reasons why attendance at the museum doubled in the weeks after the first appearance of *Gorilla gorilla* in the booming post-goldrush metropolis of Melbourne. Were they expecting to see a ghastly human alter ego, a monstrous, degraded creature, human-like but manifestly not human, embodying perhaps all the worst features of humanity, all the vices and none of the virtues? Or were they there to see and be impressed by humanity's most recently discovered long lost relative?

Of course we can never definitively answer the question; these first Australian viewers of the gorilla stand as far apart from us culturally and historically as we do biologically from the poor grinning creature in the glass case does. We do know however what first drew them in such large numbers – a letter from the Museum Director himself, Frederick McCoy, published in the local newspaper, the *Argus*. It was a letter of exhortation, calling on Melbournians to come and see the new arrival so as to adjudge for themselves.

> ... how infinitely remote the creature is from humanity, and how monstrously writers have exaggerated the points of resemblance when endeavoring to show that man is only one phase in the gradual transmutation of animals, which they assume may be brought about by external influences and which they rashly assert is proved by the intermediary character of the gorilla between the other quadramana and man (*Argus* 1865).

No clearer statement of disbelief in 'the development hypothesis' is likely to be found in the first years after the publication of Charles Darwin's *Origin of Species* in 1859. That McCoy detested evolutionary theory is clearly the case, but the battle over 'Man's Place in Nature', sparked off by Thomas Henry Huxley's book of the same name, provided the first opportunity in Australia for public discussion of Darwinism and its implications for both science and society. McCoy's letter was as much a shot in this battle – aimed clearly at Huxley and his supporters – as it was a promotional piece for the Museum.

But to say that McCoy was anti-Darwinian is in fact to say very little; an earlier historiography of science, viewing the 'Darwinian revolution' through post-Darwinian eyes, would have dismissed his position as that of an outdated scientist, a doomed representative of an earlier age of science when Natural Theology held sway. But this approach will not do anymore; thirty years of careful scholarship have shown just how complex the issues surrounding this debate over evolution really were. Perhaps the first intimations of this complexity came in the groundbreaking work of Robert Young in the early 1970s, when Darwinian scholars were reminded that ideas draw their importance from the specific social and intellectual contexts in which they originate and that their origin is itself the product of multiple cultural resources. Since then Adrian Desmond has brilliantly dissected 'the politics of evolution', demonstrating how social structure and class interest played a role in the myriad ways in which pre-Darwinian evolutionary theories were used in political and social debate, while James Moore and James Secord have built on Young's work to show again how cultural resources are utilised and in turn utilise scientific theory

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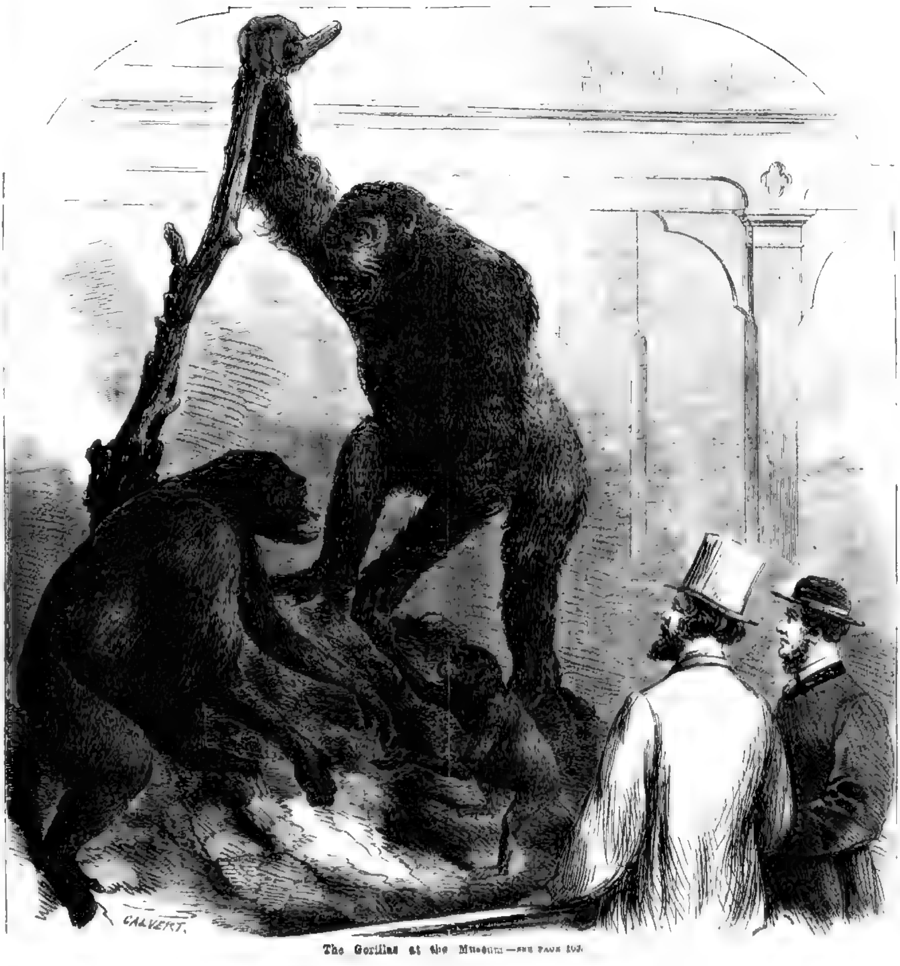

Fig. 1. The gorillas at the museum. A wood engraving by Samuel Calvert 1865. La Trobe Picture Collection, State Library of Victoria.

and practice. Simple stories of winners and losers in the development of science no longer cut the mustard (Young 1985; Desmond 1989; Desmond and Moore 1991; Secord 2000).

What I wish to do in this paper is to briefly look again at McCoy in the context of his scientific, social and cultural background. I want to suggest, albeit speculatively, that rather than his rejection of evolutionary theory being out of step with his scientific career it sits easily with his roles as geologist, Museum Director and Colonial scientific spokesman. I am not suggesting that there is full consistency in his position, only that it makes his involvement in a particular mid-Victorian Colonial cultural setting more interesting, more complex and more historically fascinating.

Learning his trade

As James Secord and contributors to this volume have shown, McCoy owed his geological training to two patrons who just happened to be giants of nineteenth-century British science Roderick Murchison and Adam Sedgwick (Secord 1986). While both were opposed to evolutionary theory of any kind, it was Sedgwick who most stridently spoke out against it. In his massive critical review of Robert Chambers *Vestiges of the Natural History of Creation*, written in 1845, a year before McCoy became his assistant, he thundered against a theory of cosmological evolution that was factually inaccurate, based on a poor philosophy of science and most crucially that 'annulled all distinction between physical and moral' and reduced human reason to nothing more than a development of animal instinct (Secord 2000: 245). Sedgwick was an evangelical Anglican, seeing in science not only the possibility of producing greater material wealth, but a moral trope that justified religion and the social order. McCoy moved from being an Irish Catholic, with all the social and professional disadvantages that entailed in mid-century Britain, to High Anglicanism. When in his later career in Australia he took up arms against the more dangerous evolutionary theory espoused by Darwin and championed by Huxley, Sedgwick's rhetoric still seemed to be ringing in his ears. In the meantime, however, he needed a job; according to Secord, his early work was not highly thought of in British scientific circles and his involvement in a long and bitter geological spat between his former and current patrons placed him in a difficult position. When Australia beckoned, both Murchison and Sedgwick came to the party and supported him for the Chair of Natural History at the University of Melbourne (Secord 1986; Wilkinson *this issue*). It was a decision that almost certainly saved his career; his contemporary James Salter, considered by many the better geologist, struggled on in near penury in a Britain where good positions in science were almost impossible to find, before finally conceding defeat and throwing himself into the Thames. For McCoy, the future might lie in a colony half a world away but it paid well and eventually led to honours he could never have expected had he stayed in the metropolitan centre, among them a knighthood, and perhaps the best of all, an FRS. When he left Britain in 1854 he took with him a goodly number of professional debts, to Sedgwick in particular. And as I implied above, among these was an aversion to evolutionary theory. At one level his sorties against evolution can be seen as repaying some of those debts; he could bring credit to his patrons by opposing theories which defied the religious, social and scientific outlook which they had done so much to foster. As it turned out, in Melbourne he found an establishment elite largely attuned to hear that message.

Going public against evolution: the social context of a scientist's actions

McCoy's involvement in the 'gorilla war' in Melbourne in the early 1860s was largely confined to offering material ammunition – anatomical specimens from the Museum and ultimately the gorilla itself. Statements of support came only within the confines of scientific meetings, especially the Royal Society of Victoria. In a sense this is a case of presenting credentials, demonstrating support for the dominant establishment view. And here 'establishment' encompasses both the scientific community and the political and religious elites in the colony – the presence and involvement of the Victorian Governor Henry Barkly, Anglican Bishop Charles Perry and the prominent Roman Catholic John Bleasdale on the side of those opposing evolution ensured that an official line would emerge and be clearly identified for public consumption in the press (Butcher 1988).

In 1869 and 1870 when McCoy presented his most celebrated public protest against evolution he did so in a forum where the same establishment interests were to the fore. The Early Closing Association had its origins in the concern of prominent Melbourne citizens to counter the rise of anti-religious and freethinking groups; local businesses were encouraged to close for a period on one day of each week in order to allow workers to attend lectures on political, religious and scientific subjects. By then McCoy was an important figure in the social and scientific fabric of the colony, his scientific orthodoxy, as defined by establishment interests, unimpeachable. With that bastion of respectability, judge Sir Redmond Barry in the Chair, he prefaced his first lecture with the comment that in a previous talk he had been criticised for saying that '... the highest scientific authorities with whom he was personally acquainted were among the most humble-minded believers of the great religious truths that could be found in any part of the community' (McCoy 1870: 1). Thus at the outset, his audience was left in no doubt about the relationship between true science and true religion. The great figures of science Sedgwick and Murchison pre-eminently provided proof that the two could, indeed must, be held together. The lecture itself simply reinforced the message, with an account of the Biblical story of creation rendered in the light of modern science, and reiteration of the message that science rightly understood was an invaluable aid to religion. For the body of his criticism of evolutionary theory he drew on Sedgwick's earlier attack on *Vestiges*, bolstered by his own observations in Australia. To account for the geographical distribution of animals and plants he turned to the 'centres of creation' theory of the Swiss-American zoologist Louis Agassiz whereby the flora and fauna of the world could be divided into six zoological provinces in both hemispheres. Each province had its own autochthonous life forms that had been created for the particular conditions existent at the time. Similarities between groups of animals and plants that were often geographically distant were explained not by recourse to any genetic relationship but as the working out of a divine plan. Discussing the idea of such provinces McCoy used the examples of the Ostrich, Rhea and Emu to show that similarity of form and habit could not be assumed to mean common ancestry, for

> … there could be no question of one of these forms having grown out of the other by a difference in surroundings for the ostrich has two toes, and the Australian and South American forms three a change not required and all three thriving when introduced into any one of the localities by man (McCoy 1870).

At the level of the particular such as this case epitomises, McCoy showed little regard for Darwinism, giving some support to the claim that he may never have read the *Origin of Species*. It is doubtful that had he done so he would have changed his view – what was to be deplored was 'the development hypothesis' itself which, whatever the mechanism underlying it, would not fit either his science, his religion or the traditional values he drew from both. He was Sedgwickian in outlook through and through. But a more provocative claim might be made which gives a fascinating twist to the story: McCoy was a geologist, and as Darwin himself admitted, geology offered little immediate support for the theory of evolution. McCoy's stance then was, even in 'scientific' terms, a reasonable one. As Susan Sheets-Pyenson points out in her study of nineteenth-century museums, other palaeontologists given the task of building up these 'cathedrals of science', such as Hermann Burmeister in Argentina and William Dawson in Canada, also treated evolution with suspicion (Sheets-Pyenson 1988). Rather than being a scientific eccentric then, McCoy fitted a pattern; and when one adds to Sheets-Pyenson's list McCoy's opposite number in Sydney, Simon Pittard, this claim gathers further strength.

In his old age McCoy complained that he had not been provided with enough money to organise the museum according to his acceptance of Agassiz's theory of 'centres of creation' (McCoy papers 1898).

The University – a centre of anti-Darwinism?

The Australian physicist William Sutherland complained that when he attended McCoy's lectures at the University of Melbourne in the 1870s he was constantly subjected to anti-Darwinian sentiment as McCoy 'thundered against' evolutionary theory. Worse, examination papers were laced with questions requiring students to critique evolutionary theory (Osborne 1920).

Was this all simply an obstinate rejection of a naturalistic theory that was rapidly overtaking his own providential philosophy of science? At one level it was certainly a rejection of that theory, but this was just one side of the coin. For forty years McCoy had worked tirelessly to uncover the secret of Australia's geological past; if his early work in Britain had indeed been poorly thought of, his Australian work was groundbreaking and original, as other papers in this volume show. Rejection of a given theory then, did not determine the quality of the work done.

Discussion and Conclusion

Towards the end of his life McCoy was showered with honours; a knighthood in 1891, an imperial award he could hardly have dreamed of when he left for Australia in 1854, and of even greater significance for understanding his scientific career, admitted to Fellowship of the Royal Society of London. The Irish Catholic turned Anglican had now entered into the highest realms of the social and scientific establishment. His achievements recognised by a scientific community that no longer shared his understanding of science rewarded him for his contribution to the understanding of Australia's paleontological history. What then did his anti-Darwinian stance do to his career? In one sense nothing; it fitted comfortably into a dominant colonial ideology where conservative religion and science were seen to be in harmony. More intriguingly, it should be seen not through the medium of a post-Darwinian world-view, but in a specific temporal and local context. Anti-Darwinism was not an eccentric excrescence on an otherwise glittering scientific career; it was part and parcel of Frederick McCoy, a bulwark against a type of godless science that he had learned to despise through his early patrons and mentors. The science he believed in had a moral edge – it led to a wonder in the face of creation and provided the intellectual stimulus to the immense amount of work he undertook and completed in Australia. His museum philosophy was guided by this essentially providentialist science; a museum must be a teaching institution, the lessons to be learnt a combination of the factual and the moral, not a place to be filled with stuffed specimens arranged higgledy-piggledy. His adherence to Louis Agassiz's 'centres of creation' was his guide in this, even though his grand plans for the National Museum never fully materialised.

As the historians of science John Brooke and Geoffrey Cantor have said, 'In writing biography the historian or biographer seeks to identify the various strands that mould the biographical subject ... through biography we might come to appreciate the existential tensions encountered by scientists as they struggle to cope with the demands made by both science and religion' (Brooke and Cantor 1998: 247). This paper is manifestly not a biography of Frederick McCoy, but in laying out, however briefly, the factors that played a role in determining his anti-evolutionism I have sought to follow that wise advice.

Look again at the grinning ape in the glass case; it symbolically brings together the twin aspects of McCoy's scientific attitude. When McCoy invited Melbournians to view the creature he was inviting them to share his vision – of an empirical science grounded in a religious, social and moral order.

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McCoy and *Sarcophilus harrisii* Boitard, 1842 – a Diabolical Relationship

W.R. Gerdtz[1]

Abstract

Frederick McCoy contributed to the knowledge of the fossil record of the Tasmanian Devil *Sarcophilus harrisii* Boitard, 1842 in Victoria by including a number of figured specimens in the *Prodromus of the Palaeontology of Victoria*. However, an article McCoy wrote under the pseudonym 'Microzoon' highlighted his anti-Darwinian thoughts and embraced a successionist viewpoint. The article, entitled 'Pre-historic Tasmanian Devils', is an interesting account of zoogeography from a successionist perspective, and is used here to contrast McCoy's anti-evolutionary viewpoint with modern Darwinian thought. A number of fossil sarcophilines discovered since McCoy's death illustrate the shortcomings of McCoy's favoured anti-Darwinian viewpoint when discussing the nature of evolution and extinction. (*The Victorian Naturalist* **118** (5), 2001, 231-233.)

Introduction

As an icon of the Tasmanian marsupial fauna, the Tasmanian Devil *Sarcophilus harrisii* Boitard, 1842, is unparalleled. Its depiction in popular culture extends from associations with sporting teams (as a symbol of aggression and determination) to children's cartoon animation, and implies the singular vision of a voracious marsupio-carnivore which cares for little else than eating and fighting. This popular misconception of the largest living dasyurid (carnivorous marsupial) is as prevalent today as it was in 1869, when Frederick McCoy published his natural history column in *The Australasian* newspaper entitled 'Pre-historic Tasmanian Devils' under the pseudonym 'Microzoon' ('Microzoon' 1869). McCoy did not identify himself as being the mysterious natural history columnist 'Microzoon'. Posthumous investigations into the numerous articles submitted under that pseudonym, however, leave little doubt as to his identity (Whitley 1969). While McCoy was not impressed with the Tasmanian Devil (nor the ecclesiastic connotations of its common name), he did seem to relish describing his contempt for *S. harrisii*. Descriptions such as 'clumsy', 'cruel', 'savage' and even '... a creature ... destitute of any redeeming quality' abound in McCoy's article, but it is McCoy's comments on the zoogeography of the species that illustrate an interesting theory. With the benefit of hindsight and a number of intriguing fossil finds since McCoy's death, a contemporary picture of the sarcophilines in time and space is slowly starting to emerge.

McCoy's *Sarcophilus*

McCoy (1882) described the fossilised remains of a number of *S. harrisii* specimens from 'many ossiferous caves of Victoria', as well as Pleistocene sediments near Camperdown, Queenscliff, Gisborne and Baringhup (McCoy 1882). These discoveries clearly posed a dilemma for McCoy as they contradicted his belief in 'The Order and Plan of Creation' (McCoy 1869). Based on ideas from an anti-Darwinian perspective, McCoy believed not in the 'struggle for existence', but rather a 'successionist' view of creation God's creations being punctuated by time and space. This theory was based on the idea that a certain faunal assemblage was 'created', existed in a finite time and space, then became entirely extinct, to be replaced by another 'batch' of God's creations. McCoy noted it a 'curious circumstance' that fossilised remains of an extant mammal from Tasmania could appear in mainland Australia, and found this 'quite inexplicable' (McCoy 1882). McCoy's belief in the Creator's perfect and universal plan of successive creation appeared to be contradicted by the fossil evidence McCoy himself described in the *Prodromus*.

The 'Microzoon' article only serves to highlight the shortcomings of the progres-

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sionist theory - surely the smaller, outlying islands of a zoogeographic region are more at risk of faunal extinction than the larger land mass of the same region, irrespective of who or what is causing the creation and extinction. Small island communities are more susceptible to extinction by virtue of the population size, so why would the exact opposite occur? While the concept of faunal refugia was not mentioned by McCoy, in attempting to explain this conundrum in the 'Microzoon' article, McCoy had inadvertently touched on what was to become a cornerstone of Darwinian evolutionary thought, Natural Selection. The extinction of *S. harrisii* on mainland Australia is now believed to be the result of two factors, the failure of the animal to adapt to increased aridity, and its inability to compete for food with an introduced species, the Dingo *Canis lupus dingo* (Strahan 1998).

Intermediate forms and fossil Sarcophilines

McCoy, like many other anti-evolutionary thinkers, quoted the lack of 'intermediate forms' between fossils and extant fauna as an argument against Darwinian evolution. McCoy had already noted a morphological similarity between *S. harrisii* and the Spot-tailed Quoll *Dasyurus maculatus*; however he did not expand his discussion to explain the implications of this similarity. In 1911, twelve years after the death of McCoy, a specimen found in a well near Smeaton was presented to the National Museum of Victoria. It appeared to represent an intermediate fossil form linking *S. harrisii* and *D. maculatus*. The fossil, later to be named *Glaucodon ballaratensis* Stirton, 1957 was a small right jawbone of a dasyurid of Plio-Pleistocene age that was almost exactly halfway between *S. harrisii* and *D. maculatus* in both morphology and dimensions. However, as the *G. ballaratensis* holotype was missing most of its teeth (and thus the most compelling evidence of its intermediate status), the specimen remained a curiosity in dasyurid evolution for 85 years, subject to discussion of dasyurid phylogeny by many authors such as Gill (1953), Stirton (1957), Ride (1964), Marshall (1973), Archer (1976, 1982), Archer and Bartholomai (1978) and Crabb (1982).

A number of other sarcophiline fossils have also surfaced since the time of McCoy. These include the small, gracile *S. moornaensis* (Crabb 1982) of the Pliocene, and the Pleistocene's gigantic cousin of today's devil, *S. laniaris* (Ride 1964). However, it wasn't until 1996 that another specimen of the genus *Glaucodon* was discovered. This new specimen was a dentally complete lower right jaw found in Batesford Quarry near Geelong. The fossil was brought to the attention of Dr Tom Rich, Curator of Museum Victoria's Vertebrate Palaeontology Department. Dr Rich's preliminary assessment was that the fossil represented a new specimen of *G. ballaratensis* (Rich *pers. comm.* 1997). This specimen will be shown in a future work to share characteristics of both *Sarcophilus* and *Dasyurus*, thus supporting Darwinian theory rather than McCoy's.

The fossil record has many instances of specimens that appear to have shared ancestral stock. The reason there is no single 'common ancestor' in any case is partly due to the highly selective conditions required for fossilisation (and thus the bias in the fossil record). This apparent stumbling block in Darwinian evolutionary theory is often used to strengthen arguments such as McCoy's successionist perspective, however upon closer examination it shows a fundamental misunderstanding of the very nature of the Darwinian theory of evolution. It is now thought the process of evolution is based on incremental changes (mutations) in genetic structure through generations, and how these changes in genetic makeup affect the populations in their environment.

McCoy subscribed to 'Successionism', a form of Creationist theory seemingly at odds with his scientific investigations into *S. harrisii*. It is possible McCoy may have interpreted the *S. harrisii* case as an anomaly which might be dealt with at a later stage within his own scientific views. In either case, this should in no way have detracted from the concise and extensive knowledge applied to describing and illustrating *S. harrisii* and its taxonomy in the *Prodromus*. McCoy's 'Microzoon' article on *S. harrisii* is therefore an interesting example of the evolution of evolutionary thinking, and illustrates that palaeontological evidence may never provide the definitive answer to the question on the mechanisms of extinction, but that scientific theories are shaped and re-shaped by new evidence and new interpretations.

Acknowledgements
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Editors' Notes

The manuscripts published in the two McCoy special issues vary in content and cover parts of his professional, scientific and private life. Some authors have waited a long time for their 'McCoy' papers to be published, and others prepared manuscripts at very short notice. All of the papers have been refereed and we are most appreciative of the time taken by everyone in contributing to these issues. To accommodate both the scientific and historical writing styles, there are some diversions from our usual referencing style. Many of the manuscripts also contain quotes, some of them lengthy; short quotes of a few lines are enclosed in single quotation marks, long quotes are indented in a smaller font size without quotation marks.

Readers will notice different spellings of McCoy throughout the issues – this is intentional. Frederick McCoy spelt his name several ways during his life. Neil Archbold's paper on page 234 in Part One illustrates the different spellings. Museum Victoria's name has also changed several times, so there are variations throughout the issues, depending on the time under discussion. Similarly, the date that McCoy became the first director also varies, as he was acting in this capacity for some time before the position was officially gazetted. The exact date of McCoy's birth is not known and varies with the source material.

There is some cross-referencing to other papers in the two issues. This has been done as a general guide and is not intended to be comprehensive. Cross-referenced papers have not been included in the reference lists at the end of manuscripts. Part One commences with a time line of Frederick McCoy's life and a geological time scale. We felt that these would be most useful to readers in an easy-to-find place as they will probably be referred to frequently.

The papers in Parts One and Two are not in strict chronological order. Part One (**118** (5)) is mainly about McCoy's early years in Ireland and also contains general historical papers. Part Two (**118** (6)) covers McCoy's scientific work in Australia and also some general historical material.

Merilyn Grey
Anne Morton
Alistair Evans

Revisiting the Real McCoy

N.W. Archbold[1]

It is well known to most naturalists and palaeontologists that there are numerous variations in the way that Frederick McCoy wrote his surname in his publications. In a note by Rushton (1979), McCoy is referred to as 'the versatile and prolific Irish naturalist and palaeontologist' and three forms of the surname are noted from McCoy's own publications (Fig. 1). Four additional variants of spelling, provided by citations of McCoy's works by other workers, are also noted by Rushton (Fig. 2). Rushton concluded that at least some of the variant forms are the result of typewriter and printing technique limitations (particularly issues concerning inverted apostrophes and the superior lower case c).

Rushton (1979) concludes his discussion by preferring the use of the form of McCoy with the inverted apostrophe (Fig. 1a) but considered that, as an alternate method, the 'rare form McCoy' could also be used. It is odd that Rushton shows little if any awareness of McCoy's work in Victoria and his long career of publishing in the colony. Indeed, McCoy could well be referred to as 'the versatile and prolific Victorian naturalist and palaeontologist'. Considerable variation occurs in the surname spelling of McCoy during the late 1850s and 1860s. McCoy's name is given in two styles, those of Fig. 1a and 1c herein, in the William Fairfax, *Handbook to Australasia* of 1859. The *Catalogue of the 1861 Victorian Exhibition* (English Edition) gives it as McCoy while the German edition gives two forms; McCoy and M'Coy). Both the *Annals and Magazine of Natural History* (1862, 1868) and the *Quarterly Journal of the Geological Society of London* (1862) use the inverted apostrophe as does the *Melbourne Intercolonial Exhibition, 1866-67, Official Record* (1867). During the same period the *Transactions and Proceedings of the Royal Society of Victoria* uses both McCoy (1860) and the inverted apostrophe version (1865).

During the 1870s, and subsequently, McCoy consistently used the lower case c as an inferior letter in his palaeontological reports for the *Progress Reports* and later *Annual Reports of the Geological Survey of Victoria*. The same form was used throughout his text for the progressively issued major works, the *Prodromus of the Palaeontology of Victoria* and the *Prodromus of the Zoology of Victoria*. These latter works ensure that 'McCoy' is the real McCoy to naturalists in Victoria (and Australia) and hence rather than being 'the rare form' of his name as stated by Rushton (1979), it is, instead, a common form.

But even in the two major *Prodromus* works there is an interesting footnote to the story. The lithographic plates for these two major works were prepared by a number of artists. Each plate was acknowledged at its base as having been prepared under the direction of McCoy, the spelling of which varies! The early plates (prepared by Ludwig Becker in the late 1850s) were directed by M'Coy, with a normal apostrophe, all subsequent plates were directed by McCoy but using the lower case c as a superior letter!

M‘COY	**A**
M^{c}COY	**B**
McCOY	**C**

Fig. 1. Three forms of McCoy's name as published. a. 1844, b. 1855, c. 1875.

M'Coy	**A**
MacCoy	**B**
Mac Coy	**C**
Mac‘Coy	**D**

Fig. 2. Four additional forms of McCoy's name as quoted from secondary sources by Rushton (1979).

Reference

Rushton, A. (1979). The real M'Coy. *Lethaia* **12**, 226.

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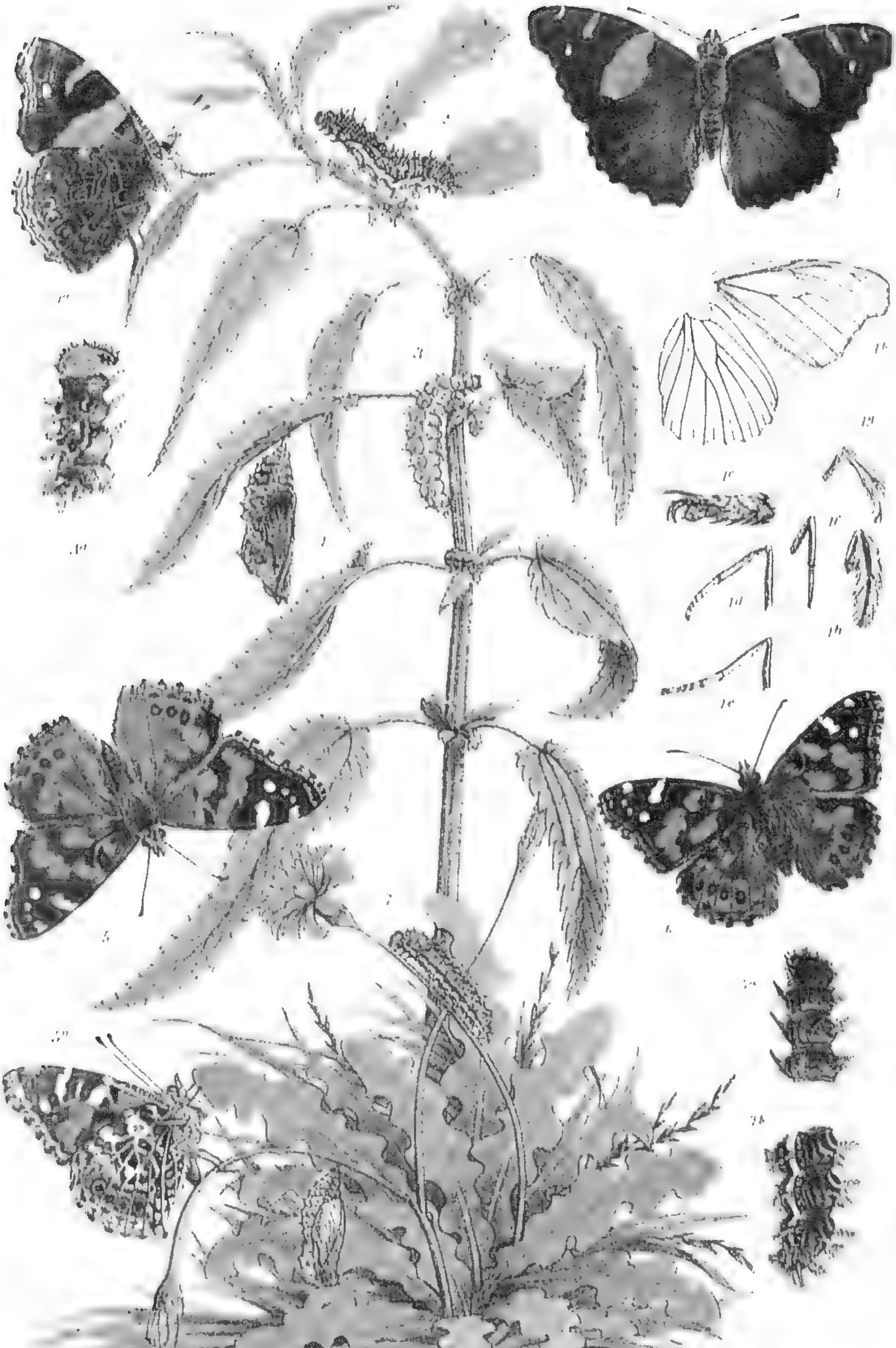

Plate 1

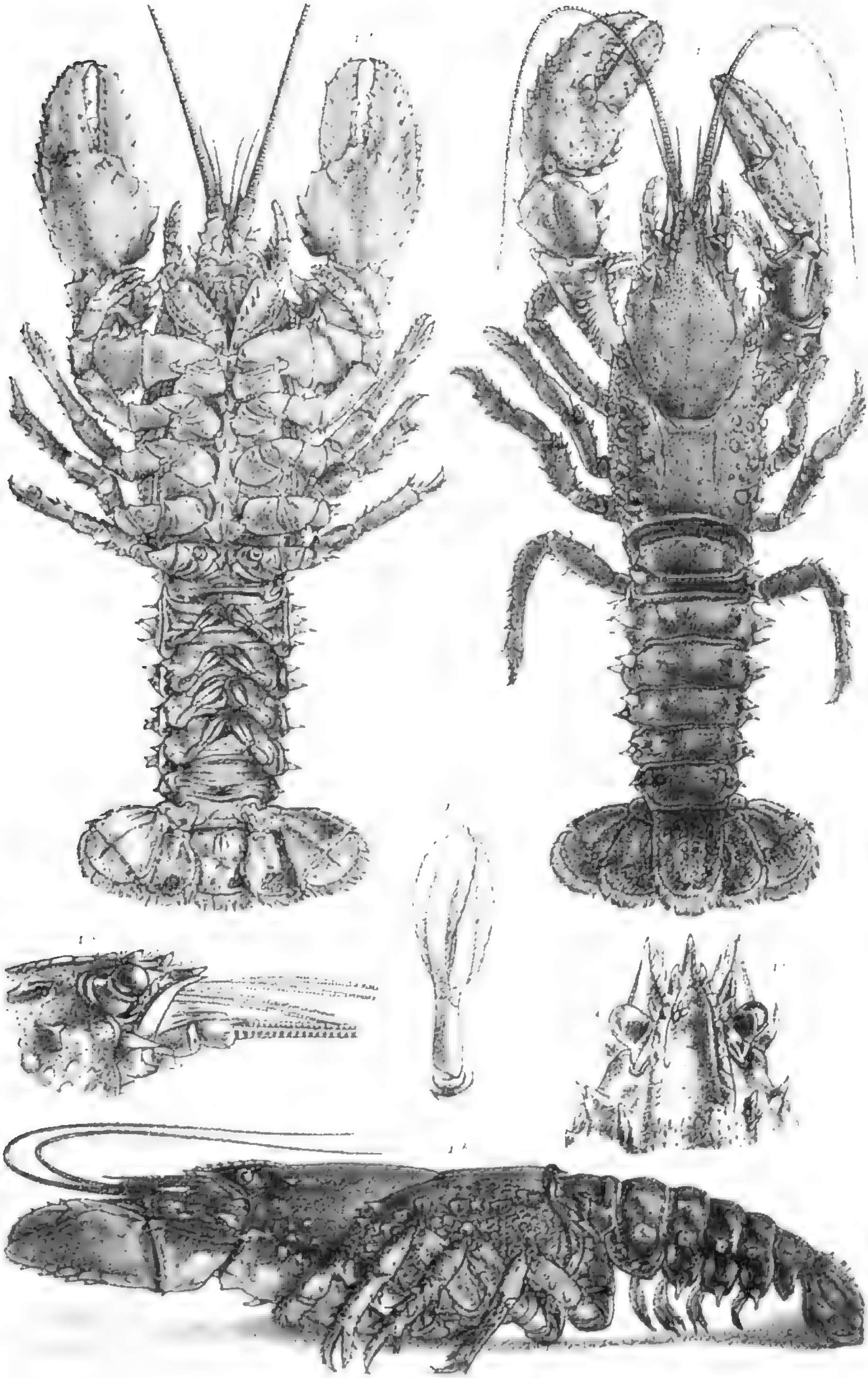

Plate 2

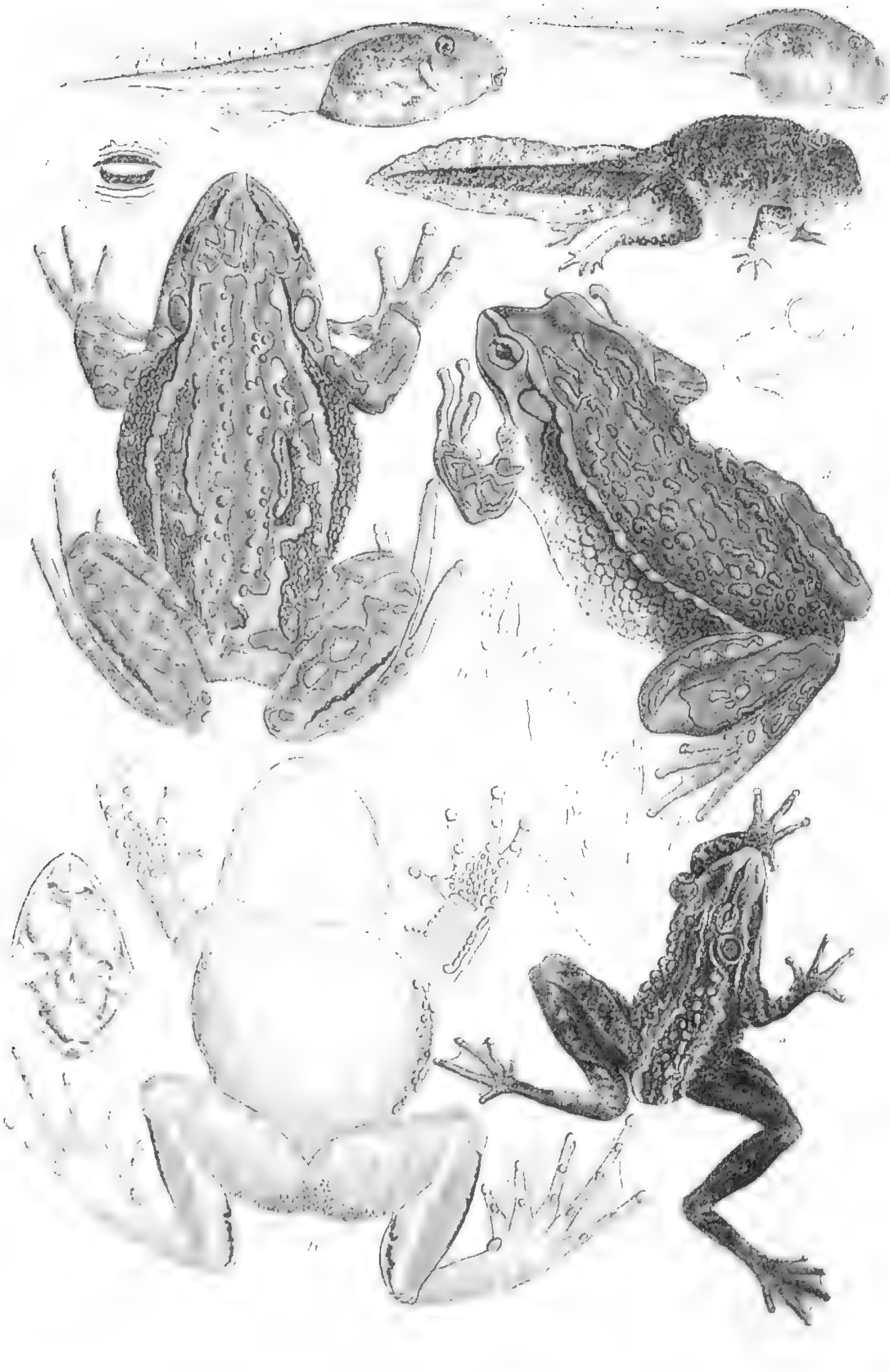

Plate 3

The

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Cover: Sir Frederick McCoy, 1891, to commemorate the award of KCMG. Reproduced courtesy of Museum Victoria.

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McCoy's *Prodromus of the Zoology of Victoria* – an Unfinished Task

A.L. Yen[1,2], S. Boyd, A.J. Coventry, J. Dixon, M. Gomon[1], M. O'Loughlin, G. Poore[1] and K. Walker[1]

Abstract
Frederick McCoy published the *Prodromus of the Zoology of Victoria* between 1878 and 1890. It included text and illustrations on 447 species of invertebrates and vertebrates. The aim was to make people more aware of Victoria's natural history. Although it was not continued after 1890, the *Prodromus* contains important biological and distributional information about many species, some of which are now threatened with extinction. (*The Victorian Naturalist* **118** (6), 2001, 242-255.)

Introduction

One of the lesser known contributions to our knowledge of the zoology of Victoria is Frederick McCoy's *Prodromus of the Zoology of Victoria*. Between 1878 and 1890, McCoy published this Zoology *Prodromus* as 20 parts in two volumes (Pescott 1954). Each part comprised 10 plates, so a total of 200 plates was published. There was often more than one species on each plate, so the total number of species recorded in the *Prodromus* was 447. McCoy also prepared a *Prodromus of the Palaeontology of Victoria*, and a more detailed account of the history of the production of both these texts is outlined by Darragh (2001).

What is a *Prodromus*? The Oxford Dictionary defines a 'prodromus' as a preliminary book or treatise. The Government of the day deemed it necessary to acquire knowledge on the geology, botany and zoology of the Colony of Victoria 'to form collections illustrative of each for the public use, and to make the necessary preparations for such systematic publications on the subject as might be useful and interesting to the general public, and contribute to the advancement of science' (McCoy 1878, in Preface to Volume 1).

McCoy stated that the publication required a large number of illustrations made of living or fresh examples of many species of reptiles, fish and the lower animals because (1) they were not as well known as the flora; (2) they lose their natural appearance shortly after death; and (3) not all true characters had been recorded, as many were described from preserved specimens. The illustrations were reproduced lithographically, and several different artists were involved (Darragh 2001). In many cases, the illustrations were the first time that the species was illustrated, sometimes for the first time in colour.

McCoy saw the *Prodromus* as a preliminary issue in the form of 'Decades' (10 plates). There was no systematic order to the sequence of publication, nor did he wait until particular groups were thoroughly known. It was aimed to encourage people to observe natural history objects and to send new material to the National Museum of Victoria for description. McCoy saw the *Prodromus* as a step towards the publication of the final systematic volume for each class when they approached completion. The publication years for each part (Decade) were 1878 (Decades 1 and 2); 1879 (3 and 4); 1880 (5); 1881 (6); 1882 (7); 1883 (8); 1884 (9); 1885 (10 and 11); 1886 (12 and 13); 1887 (14 and 15); 1888 (16 and 17); 1889 (18 and 19); and 1890 (20).

Many of the species that McCoy included in the *Prodromus* have been renamed and some species have been split into two or more species in subsequent taxonomic revisions. This paper will provide the currently accepted scientific and common names of the taxa in the *Prodromus*, as well as some notes where relevant. Information on the changes has been provided by Sue Boyd (molluscs and echinoderms); John Coventry (snakes, lizards, frogs, tortoises and turtles); Joan Dixon (mammals); Martin Gomon (fish); Mark

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O'Loughlin (echinoderms); Gary Poore (crustaceans); Ken Walker (insects); and Alan Yen (insects, earthworm).

The fauna

Not all species in the *Prodromus* were new, although a number of new species described by McCoy were included. Of the 447 species outlined in the *Prodromus*, 16 were species originally described by McCoy. However, only 14 of these species had their original descriptions in the *Prodromus*. The two species described by McCoy prior to the publication of the *Prodromus* were Leadbeater's Possum, originally described by McCoy in 1867, and the Painted Lady Butterfly (described in 1868). The following were McCoy species: the Giant Gippsland Earthworm, Gould's Squid, two species of stick insects, the Painted Lady Butterfly, four species of fish (the Two-pronged Toad-fish, the Melbourne Pelamyde, Macleay's Wrasse and the Blotch-tailed Trachinops), five species of snakes (Little Whip Snake, Common Brown Snake, Small-scaled Brown-Snake, Shield-fronted Brown Snake and the Two-hooded Furina-Snake), one species of lizard (Victorian Rhodona), one subspecies of lizard (Gippsland Water Dragon) and one mammal species (Leadbeater's Possum).

Table 1 lists the species outlined by McCoy. They have been re-arranged according to their appropriate groups rather than following the order used by McCoy. For each species, the *Prodromus* issue in which it is described, the scientific and common names given by McCoy, and the currently accepted scientific and common names are given, along with some notes of interest. Some of the species do not have a specific common name.

Polyzoa

These animals belong to the Phylum Polyzoa and are also known as Bryozoa. A total of 298 taxa was included and each was described by a polyzoan expert, Dr Paul MacGillivray, from Bendigo.

Mollusca

There were four species of molluscs, all of which were cephalopods. These were two species of cuttlefish, an octopus (Paper Nautilus) and Gould's Squid (now known as the Arrow Squid). The latter was described by McCoy.

Echinoderms

McCoy included four species of echinoderms, three species of sea stars and a species of sea urchin.

Annelida

Only one species of earthworm was included, and this was McCoy's original description of the Giant Gippsland Earthworm *Megascolides australis*.

Crustacea

A total of seven Crustacea taxa was included. He dealt with very few of the species of Crustacea now known to exist in Victoria. In the family dealt with in most detail, Parastacidae or freshwater crayfish, the number of species now recognised is far greater. With few exceptions his family, genus and species names have been revised.

Insects

McCoy dealt with 26 species of insects, including three species that he described, although one of these, the Australian Painted Lady Butterfly, had been described prior to the publication of the *Prodromus*. The insects that McCoy included in the *Prodromus* were generally large-bodied and often brightly coloured species that would generally have attracted people's attention. McCoy included the immature life history stages of moths and butterflies, which would have aided identification considerably.

Fish

The 61 species of fishes treated by McCoy make it the second largest 'group' to feature in the *Prodromus*. It is estimated that well over 600 species occur in Victorian waters. The coverage reveals a predominance of species that might have been expected to turn up in early fish markets, or species, like the Basking Shark, Briar Shark and Tasseled Anglerfish, that were perhaps brought to McCoy's attention because of their peculiar nature. Since the publication of the *Prodromus*, there have been major changes in fish taxonomy. As a result, only one of the five new species, *Trachinops caudimaculatus*, retains that name, and a large proportion of the species are now junior synonyms. Less than a third of the scientific names provided by McCoy are recognised today, with a number of the 'correct' names differing in spelling from that currently in use. Eight species have since been referred to other genera.

Though most species presented occur in Port Phillip Bay, or are oceanic species that are occasionally reported from Bass Strait coasts, one, the Sand Whiting *Sillago ciliata*, lives along the coasts of Queensland and New South Wales, and is unlikely to be found in Victorian waters. The inclusion of the Grey Nurse Shark is interesting, as is the commentary about its abundance in Port Phillip Bay where it was considered a nuisance to commercial fishers. At present, the species is all but absent from Victorian waters, and was recently considered by the Victorian Department of Natural Resources and Environment as warranting placement in a conservation category that would afford it protection.

Frogs, Snakes, Lizards, Tortoises and Turtles

McCoy included three species of frogs, 14 species of snakes, 21 species of lizards, two species of tortoises and a species of turtle. Six of these species, including four species of snakes, involved original descriptions by McCoy.

Mammals

Only five species of mammals were included, of which four were marine species. The one terrestrial species, Leadbeater's Possum, is significant because it is one of Victoria's faunal emblems. It was thought to be extinct for almost 50 years, but was rediscovered by Museum staff in 1961. Although few in number, the mammals figured and described in the *Prodromus* were treated in much detail, though McCoy's understanding of the taxonomy of the seals was confused. As an example, although he confused the taxonomy of the Australian Sea Bear, his excellent observations made on animals living on the Seal Rocks off the Nobbies on the coast of Victoria remained a primary source of information on this species until Wood Jones (1925).

Significance of the *Prodromus of the Zoology of Victoria*

McCoy, besides providing a detailed description of each species, attempted to illustrate the species in true colours. To this end, he provided illustrations of 13 species for the first time and nine species in true colours for the first time.

There was no apparent rhyme or reason as to how the species were selected for the *Prodromus*. Over half the species included were bryozoans, not a group of great public concern or interest at the time. However, McCoy used the expertise of Dr P.H. MacGillivray who was a specialist on bryozoans. Of the better known groups, no birds and only one species of non-marine mammal (Leadbeater's Possum) were included. It is likely that McCoy did not include any birds because the fauna was considered well known and there were books on the birds available, such as Gould's handbook (1865). The mammals were covered by the publications of John Gould (Gould 1845-1863). Surprisingly, given McCoy's interest in venomous snakes, there were no spiders or scorpions included. The snakes of Australia had already been well covered by Krefft (1869), but McCoy described four more species.

McCoy also provided information on the natural history of some species, both scientific and anecdotal. For example, the documented effects of the bite of a Copper-head Snake on a station-master at Elsternwick, who was considered to be at the point of death until given an injection of strong liquor of ammonia! Other information verges on the bizarre, such as McCoy's comments on a specimen of the White Pointer Shark in the Museum collection: 'Our two specimens were caught, one in July, 1873, and one in April 1877, in Hobson's Bay, near Brighton. The larger had been observed for several days swimming around the ladies' baths, looking in through the picket fence in such a disagreeable manner that the station master had a strong hook and iron chain made so as to keep the rope out of reach of his teeth, and this, being baited with a large piece of pork, made to look as much like a piece of a lady as possible, was swallowed greedily; and then, with the aid of a crowd of helpers, the monster was got on shore.'

However, there is considerable information on the distribution of many of the species during the early settlement of Melbourne that is of importance to conservation today. McCoy recorded a large number of species found in areas close to Melbourne, which may now be extinct in Victoria (such as the Earless Dragon *Tympanocryptis lineata pinguicolla*, now a full species, *Tympanocryptis pinguicolla*, which was common around Essendon and Sunbury), or locally extinct, or very much reduced in numbers (such as the Striped Legless Lizard *Delma impar*). It is interesting to note that 16 species of fish were collected from Hobson's Bay.

Another interesting side issue is whether all the species that McCoy had in his *Prodromus* are actually Victorian. One of the species that he described was the Inland Taipan or Fierce Snake. Although McCoy listed the specimens as originating from the junction of the Murray and Darling Rivers, it is likely that these specimens were collected in New South Wales during the Blandowski Expedition of 1857-8; the location is Blandowski's camp site. McCoy also stated that the Death Adder was very common in the warmer parts of northern Victoria near the Murray River; in fact, the only record of a Death Adder was a specimen from Lake Boga that had been illustrated by Krefft.

Despite its narrow scope of coverage in light of what is known about Victoria's fauna today, the *Prodromus* was a bold attempt to document the fauna. Its progression was no doubt hindered by the need to prepare colour lithographs of the species, but McCoy's initial aim to provide true colour illustrations in the days before colour photographs is laudable. The *Prodromus* was not fully recognised during McCoy's lifetime. There were efforts made in 1902, after McCoy's death, to get the Government to continue the series to cover more of the natural history of Victoria, but to no avail. It was found that McCoy had prepared more than the 200 plates in the two decades published, but he had not prepared any text to accompany these plates. The knowledge gathered by McCoy on the unpublished plates was lost upon McCoy's death (Pescott 1954). For example, McCoy prepared an illustration of a specimen of an undescribed species of legless lizard. This figured specimen is still in the Museum collection, with McCoy's proposed name, '*Pygopus porcatus*'. McCoy never wrote a formal description and this species was described by Fischer in 1882 as *Pygopus nigriceps*.

The *Prodromus* illustrates McCoy's all-round ability as a natural scientist. He was a palaeontologist, but described species from a diverse range of animal groups: snakes, lizards, squid, mammals, fish and insects. McCoy did not revise any particular groups, unlike his successor, Baldwin Spencer, who published several papers on Victorian earthworms. However, McCoy recognized that there was still a wealth of material waiting to be described, and the publication of the *Prodromus* was an important initial step in bringing this to public attention.

Acknowledgements
The authors wish to thank Dr Tom Darragh for his advice and for providing an advance copy of his article. Dr David Rentz and Mr Ted Edwards (CSIRO) checked the current names of some of the Orthoptera and Lepidoptera (insects) respectively.

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Editors' note: Some examples of the beautiful coloured lithographs from McCoy's *Prodromus of the Zoology of Victoria* are reproduced in the colour plates at the beginning and end of this issue.

Table 1. List of taxa covered by McCoy in the *Zoology Prodromus*

Prodromus Decade	Faunal group	Scientific name listed by McCoy	Common name given by McCoy	Current scientific name	Current common name	Notes
I (Plate 7)	Earthworm	*Megascolides australis* (McCoy)	The Giant Earth-Worm	*Megascolides australis* (McCoy)	Giant Gippsland Earthworm	Original description of a giant earthworm from South Gippsland. McCoy made the common error of assuming that the conical burrows of land crayfish were the surface casts of this earthworm: *M.australis* leaves its casts below ground. It has declined in its distributional range and is a protected species at the State level and was the first invertebrate to be listed as Vulnerable on the Commonwealth list.
VII (Plate 61, 62)	Mollusc	*Argonauta oryzata* (Meusch.)	Paper Nautilus	*Argonauta nodosa* Solander	Paper Nautilus	The earlier name McCoy used was placed into synonymy by Robson (1931).
VIII (Plate 76, 77)	Mollusc	*Sepioteuthis Australis* (Quoy and Gaim)	Australian Tooth-cupped Cuttlefish	*Sepioteuthis australis*	Southern Calamary	
X (Plate 100)	Echinoderm	*Goniocidaris tubaria* (Lam)		*Goniocidaris tubaria*	Slate Pencil Urchin	This species continues to be found commonly in Port Phillip and Western Port Bays as noted by McCoy.
XVII (Plate 169, 170)	Mollusc	*Ommastrephes Gouldi* (McCoy)	Gould's Squid	*Nototodarus gouldi*	Arrow Squid	
XIX (Plate 188, 189, 190)	Mollusc	*Sepia apama* Gray	Melbourne Sepia or Cuttle-fish	*Sepia apama*	Australian Giant Cuttlefish	
XX (Plate 200)	Echinoderm	*Asterina calcar* Lam.	Eight-rayed Cushion Starfish	*Patiriella calcar*	Common Sea Star	A very common shallow water sea star, as indicated by McCoy.
XX (Plate 200)	Echinoderm	*Asterina Gunnii* Gray	Gunn's Cushion Starfish	*Patiriella gunnii*	Small Sea Star	Recent molecular studies indicate that there may be more than one species in this group.
XX (Plate 200)	Echinoderm	*Pentagonaster (Tosia) aurata* (Gray)	Twelve-plated Shield-Star	*Tosia magnifica*	Greater Biscuit Star	This species is found in Port Phillip Bay but rarely seen in the shallows. McCoy accurately distinguishes this species from the more common *Tosia australis* Gray, 1840.
II (Plate 15)	Crustacea	*Astacopsis serratus* Shaw	Murray Lobster	*Euastacus armatus*	Murray Spiny Crayfish	McCoy used Astacidae, a family now confined to the northern hemisphere. The specific name *serratus* is no longer valid.
III (Plate 29)	Crustacea	*Astacopsis bicarinatus* Gray	Yabber Crayfish	*Cherax destructor*	Yabby	The Yabby is a largely Victorian species. *Cherax bicarinatus* is confined to the Northern Territory.
XV (Plate 149, 150)	Crustacea	*Palinurus Lalandii* Lam.	Southern Spiny Lobster, Melbourne Craw-fish	*Jasus edwardsii novaehollandiae*	Southern Rock Lobster	The species is at best a subspecies, genetically and morphologically only slightly distinct from the New Zealand species, *J edwardsii*. In spite of McCoy's extensive commentary *lalandi* is referable only to the South African species.
XVII (Plate 159)	Crustacea	*Palinurus Hugeli* Heller	Sydney Craw-fish or Spiny Lobster	*Jasus verreauxi*	Eastern Rock Lobster	This species is the basis of a fishery in NSW but is rare in Victoria. The species *huegeli* is generally synonymised with *verreauxi* but is a potential name for the very similar New Zealand species.
XVII (Plate 160)	Crustacea	*Astacopsis serratus* Shaw	Yarra Spiny Cray-fish	*Euastacus yarraensis*	Yarra Spiny Crayfish	Now treated as a species rather than subspecies.

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
XVIII (Plate 179, 180)	Crustacea	*Pseudocarcinus gigas* Lam.	Great Red King-Crab	*Pseudocarcinus gigas*	Tasmanian Giant Crab	This species is the heaviest crab in the world but is not a king-crab.
XX (Plate 199)	Crustacea	*Ibacus Peronii* Leach	Peron's Ibacus Crab	*Ibacus peronii*	Balmain Bug	
I (Plate 8)	Insect	*Agarista Lewini* Boisd.	Lewin's Day-moth	*Phalaenoides tristifica* (Hubner)	?	
I (Plate 8)	Insect	*Agarista Casuarinae* Scott	Loranthus Day-moth	*Comocrus behri* (Angas)	?	
I (Plate 8)	Insect	*Agarista Glycine* Lewin	Vine Day-moth	*Phalaenoides glycinae* Lew.	Vine Moth	A native species that adapted to grape vines. McCoy mentions that the Acclimatisation Society introduced the Indian Mynah to control grape pests, but the birds preferred the grapes to the insects.
I (Plate 9)	Insect	*Pieris (Thyca) Harpalyce* Don.		*Delias harpalyce* (Donovan)	Imperial White Butterfly	
I (Plate 10)	Insect	*Pieris (Thyca) Aganippe* Don.		*Delias aganippe* (Donovan)	Wood White Butterfly	
III (Plate 30)	Insect	*Zeuzera Eucalypti* Boisd. Herr.-Schaef.	Large Wattle Goat-Moth	*Xyleutes eucalypti* (Herrichs-Schäffer)	Wattle Goat Moth	
IV (Plate 40)	Insect	*Metura elongata* Saunders	Saunders' Case-Moth	*Oiketicus elongatus* Saunders	Saunders' Case-Moth	
IV (Plate 40)	Insect	*Entometa ignobilis* Walk.	Lictor Case-Moth	*Clania ignobilis* (Walker)	Faggot Case Moth	
V (Plate 50)	Insect	*Cicada moerens* (Germ.)	Great Black, or Manna cicada	*Psaltoda moerens* (Germar)	Redeye	A species that can be very common one year and absent the next. Kershaw (1897) reported thousands inhabiting a few trees near Dandenong in 1896.
V (Plate 50)	Insect	*Cyclochila Australasiae* (Donov.)	Great Green cicada	*Cyclochila australasiae* (Donovan)	Greengrocer	A species that has adapted to cities because it can utilise introduced trees such as liquidamber, weeping willow, poplar and oak.
VII (Plate 69, 70)	Insect	*Tropidoderus iodomus* (McCoy)	Violet-shouldered Phasma	*Tropidoderus iodomus* (McCoy)	?	Original description by McCoy.
VII (Plate 69, 70)	Insect	*Tropidoderus rhodomus* (McCoy)	Red-shouldered Phasma	*Tropidoderus rhodomus* (McCoy)	?	Original description by McCoy.
VIII (Plate 79)	Insect	*Acrophylla violescens* (Leach)	Violet-winged Phasma	*Didymuria violescens*	Violet Stick-insect	A species that defoliated Mountain Ash forests in the Central Highlands during the 1960-1970s.
VIII (Plate 80)	Insect	*Podacanthus typhon* (Gray)	Large Pink-winged Phasma	*Podacanthus typhon* (Gray)	?	McCoy noted that this species was found around Richmond Hill and Melbourne.
XI (Plate 109)	Insect	*Locusta vigentissima* (Serv.)	The Great Green Gum-tree Grasshopper	*Terpandrus* sp.	?	The first illustration of this species.

Prodromus **Decade**	**Faunal group**	**McCoy scientific**	**McCoy common**	**Current scientific**	**Current common**	**Notes**
XI (Plate 110)	Insect	*Edipoda musica* (Fab)	Australian Yellow-winged Locust	*Gastrimargus musicus* (Fabricus) (Acrididae)	Yellow-winged Locust	
XII (Plate 119)	Insect	*Phaneroptera valida* (Walk)	Smaller Green Gum-tree Grasshopper	*Caedicia valida*	?	
XII (Plate 120)	Insect	*Phaneroptera [Ephippitytha] trigintiduoguttata* (Serv.)	The Thirty-two Spotted Grasshopper	*Ephippitytha trigintiduoguttata* (Serville) (Tettigoniidae)	Mottled Katydid	
XIII (Plate 129)	Insect	*Acripeza reticulata* (Guérin).	The Netted Acripeza	*Acripeza reticulata* Guérin-Méneville (Tettigoniidae)	Mountain Katydid	The males of this species have full wings while the females have very reduced wings and are unable to fly.
XIII (Plate 130)	Insect	*Mantis latistylus* (Serv.)	Broad-styled Mantis	*Archimantis latistylus* (Serville)	Large Brown Mantid	
XIV (Plate 139)	Insect	*Opsomala sordida* (Aud.Serv.)	Dusky Flat-horned Locust	*Coryphistes ruricola* (Burmeister)	?	The first illustration of this species.
XIV (Plate 139)	Insect	*Mesops pedestris* (Erichson)	Pedestrian Mid-Eyed Locust	*Psednura pedestris* Erichson	?	
XIV (Plate 140)	Insect	*Tropinotus Australis* (Leach)	The Cinnamon Keel-backed Locust	*Goniaea australiasiae* (Leach)	?	
XX (Plate 197)	Insect	*Chelepteryx Collesi* (Gray)		*Chelepteryx collesi* (Gray)	White Stemmed Gum Moth	
XX (Plate 198)	Insect	*Pyrameis Kershawi* McCoy	Blue-spotted Painted-Lady Butterfly	*Vanessa kershawi* (McCoy)	Australian Painted Lady	Described by McCoy in 1868 and named after the Museum taxidermist William Kershaw who collected insects for the Museum collection.
XX (Plate 198)	Insect	*Pyrameis Itea* Fabr.	Australian Admiral Butterfly	*Vanessa itea* Fabricus	Australian Admiral	
I (Plate 4)	Fish	*Chrysophrys Australis* Günth.	Australian Bream	*Acanthopagrus butcheri* (Munro 1959)	Black Bream	Previously confused with the Yellowfin Bream *Acanthopagrus australis* of southern Queensland and New South Wales, the Black Bream was not formally recognised as distinct until nearly 1960. Both species occur in the region of Lakes Entrance.
I (Plate 5)	Fish	*Lepidotrigla Vanessa* Rich.	Spiny-sided Butterfly-Gurnard	*Lepidotrigla vanessa*	Butterfly Gurnard	The Butterfly Gurnard gets both its common and scientific name from its colorful wing-like pectoral fins which are used for display rather than flying.
I (Plate 6)	Fish	*Trigla Kumu* Lesson & Garn.	Kumu Gurnard	*Chelidonichthys kumu*	Red Gurnard	This is probably the most widely distributed of all gurnards, having been reported from South Africa to Hawaii.
II (Plate 14)	Fish	*Lates colonorum* Günth.	Gippsland Perch	*Macquaria colonurum*	Estuary Perch	Superficially resembling the barramundi of the tropics, this species was initially described in the same genus but is closely related to the Murray Cod and its freshwater relatives.

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
II (Plate 16, 17)	Fish	*Arripis truttaceus* Cuv.	Salmon Arripis	*Arripis truttacea*	Western Australian Salmon	Migratory in habit, both the Eastern Australian Salmon *Arripis trutta* and the Western Australian Salmon occur in Victorian waters, but it is likely that McCoy described the western species, which at times is common in Port Phillip Bay.
II (Plate 18)	Fish	*Trachurus trachurus* Lin	Horse Mackerel	*Trachurus declivis* (Jenyns, 1841)	Cowanyoung	Despite having been recognised as distinct by the mid-1800s, this species was given a name which applies to a northeastern Atlantic species by McCoy, a practice at the time that was not uncommon for writers whose interests were not solely fishes.
II (Plate 19)	Fish	*Lotella callarias* Günth.	Small-scaled Rock Cod	*Lotella rhacinus* (Bloch & Schneider 1801)	Largetooth Beardie	The name *Lotella callarias* was widely retained in Australia for this species until the early 1980s when it was finally accepted that the New Zealand name was a synonym and it had precedence.
II (Plate 20)	Fish	*Pseudophycis barbatus* Gunth.	Australian Rock Cod	*Pseudophycis barbatus*	Bearded Rock Cod	Like the Largetooth Beardie, this species is a common inhabitant of rock reefs of Port Phillip Bay that appeared regularly in early fish markets.
III (Plate 27)	Fish	*Genypterus australis* Cast	Australian Rockling	*Genypterus tigerinus* Klunzinger 1872	Rock Ling	Another common inhabitant of inshore reefs, the Rock Ling has been replaced in fish markets by the closely related Pink Ling, which is taken in greater numbers by deep-water trawlers.
III (Plate 27)	Fish	*Gadopsis gracilis* McCoy	Yarra Blackfish	*Gadopsis marmoratus* (Richardson, 18??)	River Blackfish	Once thought to be a single widespread species, this Australian endemic is proving to be a complex of species, each isolated in localised drainages
III (Plate 28)	Fish	*Scomber pneumatophorus* De la Roche	Southern Mackerel	*Scomber australasicus* Cuvier, in Cuvier and Valenciennes 1831	Blue Mackerel	The three species in the genus *Scomber* are by far the most commercially important of the mackerels and tunas throughout the world. The local Blue Mackerel is fished both for human consumption and pet food.
IV (Plate 33)	Fish	*Sebastes percoides* Solander	Banded Red Gurnet-Perch	*Helicolenus percoides* (Richardson 1842)	Ocean Perch	There appear to be two species going under this name, a darkly patterned shallow water form and a paler deep water form, but further work is required to properly separate the two.
IV (Plate 34)	Fish	*Rhina squatina* Lin.	Angel-fish	*Squatina australis* Regan 1906	Angelshark	Angelsharks are midway between sharks and rays in appearance, retaining the lateral gill slits of sharks but developing the close association of the pectoral fins and flattened head of rays.
V (Plate 43)	Fish	*Crossorhinus barbatus* (Lin.)	Carpet Shark	*Orectolobus ornatus* (DeVis 1883)	Banded Wobbegong	The highly camouflaged wobbegongs are usually inactive during daylight hours, preferring to forage about their algal covered reefs at night.
V (Plate 43)	Fish	*Notidanus [Heptanchus] Indicus* (Cuv)	Seven-gilled Shark	*Notorynchus cepedianus* (Peron 1807)	Broadnose Sevengill Shark	This shark has a primitive feature of seven gill slits, instead of the five of 'modern' sharks, and teeth that match those of fossil relatives living 40-50 million years ago.
V (Plate 44)	Fish	*Thersites atun* (Cuv)	Barracouta	*Thyrsites atun*	Barracouta	Once an extremely important food fish in southern waters, Barracouta populations have declined to the point where it is rarely seen in markets.
V (Plate 44)	Fish	*Thynnus Thynnus* (Lin.)	The Tunny	*Thunnus maccoyii* Castelnau 1872	Southern Bluefin Tuna	Described by McCoy well before the publication of the *Prodromus*, he evidently did not consider it to be a species distinct from Bluefin Tuna of the Northern Hemisphere.

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
VI (Plate 54, 55)	Fish	*Aulopus purpurissatus* (Rich.)	Australian Aulopus	*Aulopus purpurissatus*	Sergeant Baker	A species associated with rocky reefs of the open coast, the Sergeant Baker has long been considered a desirable food fish, but is not often seen in markets.
VI (Plate 56)	Fish	*Zygaena malleus* (Shaw)	Hammer-headed Shark	*Sphyrna zygaena* (Linnaeus 1758)	Smooth Hammerhead	While other species of hammerhead shark occur in tropical oceans, the Smooth Hammerhead is distributed in temperate regions throughout the world.
VI (Plate 56)	Fish	*Pristiophorus nudipinnis* (Günth)	Common Australian Saw-Fish	*Pristiophorus nudipinnis*	Southern Sawshark	The saw-like rostrum of sawsharks has developed quite independently from that of sawfish, although it is likely to be used in both for wounding prey.
VII (Plate 63)	Fish	*Myliobatus australis* (Macleay)	Blue-spotted Eagle-Ray	*Myliobatus australis*	Southern Eagle Ray	These rays are powerful swimmers that cruise sandy coastal shorelines in search of shellfish, on which they feed.
VII (Plate 64)	Fish	*Odontaspis taurus* (Rafin.)	Long-Toothed Bull-Shark, Shovel-nosed Shark	*Carcharias taurus*	Grey Nurse Shark	Now all but absent from Victorian waters, the Grey Nurse Shark was said by McCoy to be so common in Port Phillip Bay as to be a nuisance.
VII (Plate 64)	Fish	*Galeus australis* (Macleay)	Australian Tope Shark	*Galeorhinus galeus* (Linnaeus 1758)	School Shark	A temperate species of most oceans, the School Shark is a major component of the Victorian flake fishery and, as a result, is declining in numbers.
VII (Plate 65)	Fish	*Phyllopteryx foliatus* (Shaw)	Leafy Sea-Dragon	*Phyllopteryx taeniolatus* (Lacepède 1804)	Common or Weedy Seadragon	One of the unique fishes of southern Australia, this species is more widely distributed than the true Leafy Seadragon, which is confined to Australia's central southern and southwestern coasts.
VII (Plate 65)	Fish	*Hippocampus breviceps* (Peters)	Short-Headed Sea-Horse	*Hippocampus breviceps*	Shortsnout Seahorse	This is the smaller of two seahorses living in bays and coastal waters of Australia's southern coasts.
VIII (Plate 73)	Fish	*Girella simplex* (Rich.)	Ludrick	*Girella tricuspidata* (Quoy and Gaimard 1824)	Luderick	This species is more commonly known as blackfish along the New South Wales coast, where it is an extremely popular angling fish.
VIII (Plate 74)	Fish	*Carcharodon Rondeletii* (Müll. and Hen.)	White Shark	*Carcharodon carcharias* (Linnaeus 1758)	White Pointer	Referred to as the Great White Shark elsewhere in the world, this is the feared 'man eating shark' of maritime lore.
VIII (Plate 75)	Fish	*Acanthias vulgaris* (Linn.)	Picked Dog-Fish	*Squalus acanthias* Linnaeus 1758	White-spotted Spurdog	This species is fished heavily in the Atlantic for the fish and chip market, but is largely ignored in Australia because of the small size of the population. It has virtually disappeared from Victorian waters.
IX (Plate 84)	Fish	*Ctenolates ambiguus* (Rich)	Murray Golden Perch	*Macquaria ambigua*	Golden Perch	The Golden Perch is a popular food fish of the Murray-Darling River system but does not occur naturally south of the Great Divide.
IX (Plate 85, 86)	Fish	*Oligorus Macquariensis* (Cuv. and Val.)	Murray Cod-Perch	*Maccullochella peelii* (Mitchell 1838)	Murray Cod	Also confined to the Murray-Darling River system, the Murray Cod is Australia's largest bony fish, reaching 1.8m and 110 kg.
IX (Plate 87)	Fish	*Mustelus Antarcticus* (Günth.)	Australian Smooth-Hound	*Mustelus antarcticus*	Gummy Shark	The Gummy Shark receives its common name from the pavement-like teeth in its jaws, in contrast to the pungent teeth of most sharks.
IX (Plate 88)	Fish	*Alopecias vulpes* (Linn.)	The thresher, or Long-tailed Shark	*Alopias vulpinus* (Bonnaterre 1788)	Thresher Shark	Thresher Sharks are distinctive sharks of the world's open oceans, having a greatly elongated upper lobe of the tail fin. This is the most widely distributed of the three species and reaches well into temperate regions of both hemispheres.

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
XI (Plate 104)	Fish	*Cetorhinus maximus* (Linn.)	Basking Shark	*Cetorhinus maximus*	Basking Shark	The Basking Shark attains a length of 10 m and is the cold-water equivalent of the Whale Shark, both feeding on relatively tiny plankton.
XII (Plate 112)	Fish	*Callorhynchus antarcticus* (Lacep)	Southern Chimaera	*Callorhinchus milii* Bory de St. Vincent 1823	Elephantfish	This odd-looking primitive fish, like sharks and rays, retains a cartilaginous skeleton and has modified pelvic fins for internal fertilisation. Its strange elephant-like snout has a sensory function.
XII (Plate 113)	Fish	*Heterodontus Phillipi* (Lacep)	Port Jackson Shark, or Bull-dog Shark	*Heterodontus portusjacksoni* (Meyer 1793)	Port Jackson Shark	The primitive Port Jackson Shark has pointed grasping teeth at the front of the jaws, and crushing molars at the rear.
XII (Plate 114)	Fish	*Trachichthys Australis* (Shaw)	Australian Rough Fish	*Trachichthys australis*	Roughy	This southern Australian endemic has a noxious mucus secreted by its skin which helps protect it from predation.
XII (Plate 115)	Fish	*Lanioperca mordax* (Günth.)	The Skip-jack Pike	*Dinolestes lewini* (Griffith 1834)	Longfin Pike	Resembling a barracuda with its prominent predatory teeth and slender shape, the Longfin Pike is actually a very specialised cardinalfish.
XIII (Plate 122)	Fish	*Trachypterus taenia* (Bloch)	The Southern Silver Ribbon-fish	*Trachypterus arawatae* Clarke 1881	Ribbonfish	Ribbonfish live in surface waters throughout the world oceans where they feed on large concentrations of tiny shrimp and krill.
XIII (Plate 123)	Fish	*Chironectes bifurcatus* (McCoy 1886)	Two-pronged Toad-fish	*Rhycherus filamentosus* (Castelnau 1872)	Tasselled Anglerfish	Southern Australia has the world's greatest diversity of shallow-dwelling anglerfish, like this well camouflaged species that lives on algal-covered reefs.
XIII (Plate 124)	Fish	*Monacanthus Brownii* (Rich)	Brown's Tooth brush Leather-jacket	*Acanthaluteres vittiger* (Castelnau 1873)	Toothbrush Leatherjacket (male)	The Toothbrush Leatherjacket is named for a prominent patch of bristles which develops on either side of the base of the tail in mature males.
XIII (Plate 125)	Fish	*Monacanthus hippocrepis* (Quoy and Gaim)	Horse-shoe-marked Leather-jacket	*Meuschenia hippocrepis*	Horseshoe Leatherjacket	The name of the Horseshoe Leatherjacket is attributable to the distinctive marking on each side of the body, particularly well developed in males.
XIV (Plate 133)	Fish	*Brama Raii* (Bloch)	Ray's Sea Bream	*Brama brama* (Bonnaterre 1788)	Pomfret	This is a streamlined open water species occurring in all but the coldest parts of the world's oceans.
XIV (Plate 134)	Fish	*Labrichthys Bleekeri* (Cast)	Bleeker's Parrot fish	*Notolabrus tetricus* (Richardson, 1840)	Bluethroat Wrasse	The most abundant species of wrasse in Victorian coastal waters, this species is often regarded as a nuisance by anglers fishing from rocks along the open coast.
XIV (Plate 135)	Fish	*Hemirhamphus intermedius* (Cant.)	Black-finned Half beak or Sea Gar-fish	*Hyporhamphus melanochir* (Valenciennes, in Cuvier & Valenciennes 1846)	Southern Sea Garfish	Closely related to flying fish, the Garfish is a popular angling and food species taken in bays and estuaries along the southern coast.
XIV (Plate 135)	Fish	*Scombresox saurus* (Bloch, sp.: var. Forsteri, Cuv. and Val.)	Saury Pike	*Scomberesox saurus*	Saury	The Sauries resemble the tropical Long Toms, but are less attenuate, lack teeth in their jaws and form huge schools that are often attacked by predatory species.
XV (Plate 143)	Fish	*Monacanthus Peronii* (Hollard)	Peron's Leatherjacket	*Acanthaluteres vittiger* (Castelnau 1873)	Toothbrush Leatherjacket (female) apparently a misidentification	McCoy's description appears to have been based on a Female Toothbrush Leatherjacket. A specimen resembling the figure and marked as being drawn is in the MV collection.

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
XV (Plate 144)	Fish	*Echinorhinus spinosus* (Lin.)	Spinous Shark	*Echinorhinus brucus* (Bonnaterre 1788)	Bramble Shark	The specimen used by McCoy as the basis of this account was later designated as a holotype of *Echinorhinus (Rubusqualus) mccoyi* by Whitley (1931).
XV (Plate 145)	Fish	*Regalecus Banksi* (Cuv.)	Banks' Oar-Fish	*Regalecus glesne* Ascanius 1772	Oarfish	The oarfish is probably the longest bony fish in the world, attaining a length of at least 8 m, but reported to reach 17 m.
XVI (Plate 154)	Fish	*Cybium Commersoni* (Lacép)	Commerson's Mackerel	*Scomberomorus commerson*	Narrow barred Spanish Mackerel	This is a migratory gamefish of the tropical Indo-West Pacific which is only occasionally taken in the easternmost parts of Victorian coastal waters.
XVI (Plate 155)	Fish	*Pelamys Schlegeli* (McCoy)	Melbourne Pelamyde	*Sarda australis* (Macleay 1881)	Australian Bonito	This species has one of the most restricted distributions of the tuna-like fishes, being confined to southeastern Australia, New Zealand and Norfolk Island.
XVII (Plate 163)	Fish	*Labrichthys laticlavius* (Rich)	Broad-striped or Senator Parrot-fish	*Pictilabrus laticlavius*	Senator Wrasse	The Senator Wrasse is a common inhabitant of the algal covered reefs along Australia's exposed southern coasts.
XVII (Plate 164)	Fish	*Heteroscarus Macleayi* (McCoy)	Macleay's Wrasse	*Odax acroptilus* (Richardson, in Richardson and Gray 1846)	Rainbow Cale	The fused jaw teeth and rather deep body of this attractive species has caused it to be incorrectly placed with the tropical parrotfishes by some authors.
XVIII (Plate 172)	Fish	*Seriola Lalandi* Cuv. & Val.	Yellow-Tail	*Seriola lalandi*	Yellowtail Kingfish	The Yellowtail Kingfish is a popular gamefish in many parts of the cool tropical and warm temperate waters of the Southern Hemisphere and North Pacific.
XVIII (Plate 173)	Fish	*Chilodactylus carponemus* Cuv. & Val.	Long-Fingered Chilodactylus	*Nemadactylus valenciennesi* (Whitley, 1937)	Queen Snapper	Confined to southern Australia, the Queen Snapper is only occasionally taken commercially but is considered to have high quality flesh.
XVIII (Plate 174)	Fish	*Chilodactylus carponemus* Cuv. & Val.	Long-Fingered Chilodactylus Var.	*Nemadactylus valenciennesi* (Whitley, 1937)	Queen Snapper	
XIX (Plate 182)	Fish	*Sillago ciliata* Cuv. & Val.	Plain Whiting	*Sillago ciliata*	Sand Whiting	This whiting is common along the eastern coast of Australia, but rarely enters Victorian waters.
XIX (Plate 183)	Fish	*Temnodon saltator* Linn.	Skipjack	*Pomatomus saltatrix*	Tailor	The Tailor received its common name from the shear-like nature of its powerful jaws.
XIX (Plate 184)	Fish	*Arripis Georgianus* Cuv. & Val.	Roughy	*Arripis georgianus*	Tommy Rough	Extremely similar in appearance to the two species of Australian salmon, the Tommy Rough fails to attain even half their length and is not often seen larger than 25 cm.
XX (Plate 192)	Fish	*Callionymus calauropomus* Ric.	Crook-spined Dragonet	*Callionymus calauropomus*	Common Stinkfish	As might be expected, stinkfish have a strong smelling skin mucus, which also affects the palatability of their flesh.
XX (Plate 193)	Fish	*Neosebastes scorpaenoides* Guich.	Spotted Red Guernet-Perch	*Neosebastes scorpaenoides*	Ruddy Gurnard Perch	All scorpionfishes in southern waters have a painful venom associated with their fin spines, but this is one of the few that is regularly taken by hook and line.
XX (Plate 194)	Fish	*Trachinops caudimaculatus* McCoy	Blotch-tailed Trachinops	*Trachinops caudimaculatus*	Southern Hulafish	First described by McCoy in the *Prodromous*, this is one of the most common species found around rocky reefs in Port Phillip Bay.
I (Plate 1)	Snake	*Pseudechys porphyriacus* Shaw	Black Snake	*Pseudechis porphyriacus* Shaw	Red-bellied Black Snake	

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
I (Plate 2)	Snake	*Hoplocephalus superbus* Günth.	Copper-head Snake	*Austrelaps superbus* Gunther	Lowland Copperhead Snake	Copperheads have now been split into three species, two of which occur in Victoria. The specimen illustrated is a Lowland Copperhead Snake.
I (Plate 3)	Snake	*Hoplocephalus curtus* Schl.	Tiger Snake	*Notechis scutatus* (Peters)	Tiger Snake	
II (Plate 11)	Snake	*Hoplocephalus flagellum* McCoy	Little Whip Snake	*Suta flagellum* (McCoy)	Little Whip Snake	
II (Plate 11)	Snake	*Hoplocephalus coronoides* Günth.	White-lipped Snake	*Drysdalia coronoides* (Gunther)	White-lipped Snake	
II (Plate 12)	Snake	*Acanthophis Antarctica* Shaw	Death Adder	*Acanthophis antarctica* (Shaw & Nodder)	Death Adder	
II (Plate 13)	Snake	*Morelia variegata* Gray	Carpet Snake	*Morelia spilota variegata* Gray	Carpet Snake	
III (Plate 23)	Snake	*Diemenia superciliosa* Fisch.	Common Brown Snake	*Pseudonaja textilis* (Dumeril, Bibron & Dumeril)	Common Brown Snake	
III (Plate 23)	Snake	*Diemenia microlepidota* McCoy	Small-scaled Brown Snake	*Oxyuranus microlepidotus* (McCoy)	Inland Taipan or Fierce Snake	
III (Plate 23)	Snake	*Diemenia aspidorhyncha* McCoy	Shield-fronted Brown Snake	*Pseudonaja nuchalis* Gunther	Western Brown Snake or Gwardar	
IV (Plate 32)	Snake	*Furina bicucullata* McCoy	Two-hooded Furina-Snake	*Pseudonaja textilis* (Dumeril, Bibron & Dumeril)	Common Brown Snake	This description was based on a juvenile specimen.
V (Plate 41)	Lizard	*Hydrosaurus varius* (Shaw)	Lace Lizard	*Varanus varius* (White, ex Shaw)	Lace Monitor	
V (Plate 42)	Frog	*Limnodynastes Tasmaniensis* (Günth.)	Spotted Marsh-Frog	*Limnodynastes tasmaniensis* (Gunther)	Spotted Marsh Frog	
V (Plate 42)	Frog	*Limnodynastes dorsalis* (Gray)	Common Sand-Frog	*Limnodynastes dumerilli*	Pobblebonk	This species has been divided into five subspecies, three of which occur in Victoria. Figure 2 appears to be *Limnodynastes dumerilli insularis* while Figure 2a appears to be intermediate between *L. d. insularis* and *Limnodynastes dumerilli dumerilli*
VI (Plate 51)	Lizard	*Rhodona Officeri* (McCoy)	Victorian Rhodona	*Lerista punctatovittata* (Gunther)	No common name	This was described from a unique live specimen which was apparently never accessed into the Museum collection and is presumably lost.
VI (Plate 52)	Snake	*Vermicella annulata* (Gray)	Black and White Ringed Snake	*Vermicella annulata* (Gray)	Bandy Bandy	
VI (Plate 53)	Frog	*Ranoidea aurea* (Less.)	Green and Golden Bell-Frog	*Litoria raniformis* (Keferstein)	Growling Grass Frog	A member of the *Litoria aurea* complex, and for many years considered a subspecies.
VIII (Plate 72)	Lizard	*Cyclodus gigas* (Bodd)	Northern Blue-tongued Lizard	*Tiliqua scincoides* (White, ex Shaw)	Common Blue-tongue	

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
IX (Plate 81)	Lizard	*Physignathus Lesueri* (Gray) var *howitti* (McCoy)	Gippsland Water Lizard	*Physignathus lesueurii howittii* McCoy	Gippsland Water Dragon	
IX (Plate 82, 83)	Tortoise	*Chelymys Macquaria* (Cuv.)	Murray Tortoise	*Emydura macquarii* (Gray)	Short-necked Tortoise	
X (Plate 92, 93)	Tortoise	*Chelodina longicollis* (Shaw)	Long-necked River Tortoise	*Chelodina longicollis* (Shaw)	Long-necked Tortoise	
XI (Plate 101)	Turtle	*Sphargis coriacea* (Linn)	Luth, or Leathery Turtle	*Dermochelys coriacea* (Vandelli)	Luth	
XI (Plate 102)	Lizard	*Trachydosaurus rugosus* (Gray)	Rugged Stump-tail or Shingle-back Lizard	*Trachydosaurus rugosus* (Gray)	Sleepy Lizard	
XI (Plate 103)	Snake	*Typhlops nigrescens* (Gray)	Blackish Australian Worm-Snake	*Ramphotyphlops nigrescens* (Gray)	Blind Snake	
XII (Plate 111)	Lizard	*Grammatophora muricata* (Shaw)	The Blood-sucker	*Amphibolurus muricatus*	Tree Dragon	
XIII (Plate 121)	Lizard	*Grammatophora barbata* (Kaup)	The Bearded Lizard	*Pogona barbata* (Cuvier)	Bearded Dragon or Jew Lizard	Part of *the P. barbata* complex, which has two species in Victoria.
XIV (Plate 131)	Lizard	*Cyclodus nigroluteus* (Quoy and Gaim.)	Southern or Blotched, Blue-tongued Lizard	*Tiliqua nigrolutea* (Quoy and Gaimard)	Blotched Blue-tongue Lizard	
XIV (Plate 132)	Lizard	*Phyllurus Milusii* (Bory)	Thick-tailed Gecko	*Underwoodisaurus milii* (Bory de St Vincent)	Thick-tailed Gecko	
XIV (Plate 132)	Lizard	*Diplodactylus marmoratus* (Gray)	Marbled Gecko	*Christinus marmoratus* (Gray)	Marble Gecko	
XV (Plate 141)	Lizard	*Egernia Cunninghami* (Gray)	Spiny-ridged Lizard	*Egernia cunninghami* (Gray)	Cunningham's Skink	
XV (Plate 142)	Snake	*Pseudechys Australis* (Gray)	Brown pseudechys	*Pseudonaja textilis* (Dumeril, Bibron & Dumeril)	Common Brown Snake	McCoy's description, together with the description of *Pseudechis australis* Krefft 1865 of a snake from Fort Bourke, N.S.W., was used by Boulenger in 1896 to erect a new species which he named *Pseudechis cupreus*. McCoy's specimen is in fact a Common Brown Snake, while Krefft's specimen was a *Pseudechis australis* (Mulga or King Brown Snake, a species which has not been recorded from Victoria).
XVI (Plate 151)	Lizard	*Monitor Gouldi* (Gray)	Gould's Monitor Lizard	*Varanus gouldii* (Gray)	Gould's, or Sand Goanna	
XVI (Plate 152)	Lizard	*Pygopus lepidopus* (Lacép)	Pygopus	*Pygopus lepidopodus* (Lacepede)	Common Scaly Foot	
XVI (Plate 153)	Lizard	*Delma Frazeri* (Gray)	Frazer's Delma	*Delma inornata* Kluge	Legless Lizard	
XVII (Plate 161)	Lizard	*Lialis Burtoni* (Gray)	Burton's Lialis	*Lialis burtonis* (Gray)	Burton's Legless Lizard	This species is actually illustrated in Plate 162, but belongs to the text for Plate 161

Prodromus Decade	Faunal group	McCoy scientific	McCoy common	Current scientific	Current common	Notes
XVII (Plate 162)	Lizard	*Aprasia pulchella* (Gray)	Lined Aprasia	*Aprasia striolata* Lutken	Worm Lizard	This species is actually illustrated in Plate 161, but belongs to the text for Plate 162
XVII (Plate 162)	Lizard	*Pseudodelma impar* (Fischer)	Fischer's False Delma	*Delma impar* Fischer	Striped Legless Lizard	Now considered a threatened species within Victoria.
XVIII (Plate 171)	Lizard	*Cyclodus occipitalis* Peters	Broad-Banded or Occipital Blue-Tongue Lizard	*Tiliqua occipitalis* (Peters)	Western Blue-Tongue	
XIX (Plate 181)	Lizard	*Tympanocryptis lineata* Peters	White-Streaked Earless Dragon	*Tympanocryptis lineata pinguicolla* Mitchell	Earless Dragon	Now considered a threatened species within Victoria, no records having reached the museum since 1967.
XX (Plate 191)	Lizard	*Hinulia Whitei* Lacep.	White's Hinulia Lizard	*Egernia whitii* (Lacepede)	White's Skink	
XX (Plate 191)	Lizard	*Hinulia Quoyi* Dum. & Bib.	Quoy's Hinulia Lizard	*Eulamprus tympanum tympanum* (Lonnberg & Andersson)	Water Skink	This species is part of the *Eulamprus quoyi* complex, which has three species in Victoria.
III (Plate 21)	Mammal	*Stenorhynchus leptonyx* de Blainv.	Sea-Leopard Seal	*Hydrurga leptonyx*	Leopard Seal	Common in the Antarctic pack-ice. Stragglers, often in poor condition, are known from Victorian waters, including Port Phillip Bay, from July to October.
III (Plate 22)	Mammal	*Delphinus Novae Zealandiae* Quoy & Gaim.	Yellow-sided Dolphin	*Delphinus delphis*	Common Dolphin	This species strands frequently on the Victorian coast, and is found inside Port Phillip Bay, probably following influxes of fish. The McCoy text makes one minor confusing comment by referring to it as the 'Bottle-nose' of sailors, a different species (*Tursiops truncatus*).
IV (Plate 31)	Mammal	*Euotaria cinerea* Peron	Australian Sea-Bear or Fur-Seal	*Arctocephalus pusillus doriferus*	Australian Fur Seal	McCoy devoted two accounts to this species as the first figure (Plate 31) did not show the typical land habit of the species. Details for Plate 31 duplicate many of those in Plate 71, but the former is more devoted to anatomy than the latter, which includes ecological comments.
VIII (Plate 71)	Mammal	*Euotaria cinerea* (Péron)	Australian Sea-Bear or Fur-Seal	*Arctocephalus pusillus doriferus*	Australian Fur Seal	See previous.
X (Plate 91)	Mammal	*Gymnobelideus Leadbeateri* (McCoy)	Not indicated	*Gymnobelideus leadbeateri*	Leadbeater's Possum	Described by McCoy in 1867. He did not designate a type specimen, but a lectotype was selected by Dixon in 1970. The species is not currently known in the Bass River where it was first located, but occurs in the Central Highlands. Its specific living requirements have led to its present endangered status. It is one of the faunal emblems of Victoria.

The Bryozoa of McCoy's *Prodromus*

Philip Bock[1]

Abstract

Of the 200 plates published in McCoy's *Prodromus of the Zoology of Victoria*, 61 were devoted to bryozoans, documenting 309 species from the Port Phillip region. This major contribution to the knowledge of marine life of the colony was clearly the result of close co-operation between Sir Frederick McCoy and Dr Paul MacGillivray. Although much of this fauna has been revised by later workers, and much more revision is still needed, the account in the *Prodromus* remains the most significant single contribution to the taxonomy of Australian bryozoans. (*The Victorian Naturalist* **118** (6), 2001, 256-265)

The Polyzoa of the *Prodromus of the Zoology of Victoria*

Numerically, the majority of species figured in the twenty issues of the *Prodromus of the Zoology of Victoria* (MacGillivray 1879-1890), belong to the Phylum Polyzoa, now generally known as the Bryozoa, or Ectoprocta. These descriptions were undertaken by Dr Paul H. MacGillivray, who lived in Bendigo until his death in 1895. MacGillivray commenced his work on Australian bryozoans with a brief paper in the *Transactions of the Philosophical Institute* (MacGillivray 1860a), which was read at a meeting on 3 August, 1859. Clearly, MacGillivray and McCoy were near-contemporaries. Many species described in early papers were collected at Queenscliff, and some were described from material collected by several other people, including Baron Ferdinand von Mueller.

Nine years later, a further paper describing 48 new species was published (MacGillivray 1869). The descriptions and comments in this paper show greater experience and care than the earlier papers, but the descriptions were not accompanied by illustrations. At this stage, MacGillivray announced his intention to provide figures for these species, together with others from Victoria 'in Professor M'Coy's "Memoirs of the Museum" '. As the first Decade of the *Prodromus* was not published until 1878, and the first bryozoan account did not appear until Decade 3, in 1879, it is clear that an extended period of planning and preparation went into the series.

A total of 309 species or varieties of bryozoans was figured and described in the 18 decades. Twenty-six of these species were previously undescribed (Table 1, species indicated as 'n. sp.'). The majority of species defined from the local fauna had been introduced by MacGillivray earlier, in issues of the *Transactions and Proceedings of the Royal Society of Victoria* published shortly before the publication of the relevant issue of the *Prodromus*.

The sequence of descriptions and illustration shows considerable change over time. The plates in Decade 3 are not aesthetically attractive, and each figure is tiny, but there is a large amount of detail. The figures are usually quite accurate and useful in identification. Plates 35 to 38 in Decade 4 are rather less satisfactory, although the same artist prepared the plates. These plates are of encrusting forms, and I believe that a factor contributing to the lack of detail is the difficulty of discerning skeletal structure when it is covered by cuticle. At least a few of the specimens in the collection of Museum Victoria have been calcined, a procedure which involved using a blowpipe to burn the organic material. These specimens have now completely disintegrated, and are useless for observation. However, the material used for the illustrations is generally intact, although some specimens in slides constructed from wood have suffered from 'shell disease', or 'Bind's disease', which can be attributed to reactions between volatiles from the wood and the skeletal material.

In Decade 5, the individual figures are larger, and the rendering, while simpler, is much clearer. A new artist, J. Ripper, prepared the plates in Decades 5 to 13. Commencing in Decade 10, some plates indicate that Dr MacGillivray worked together with J. Ripper in the draughting,

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with lithography by Ripper. The plates in Decades 14 to 20 were draughted by MacGillivray, and lithographed by Ripper. The quality and accuracy of the figures are generally very fine, although some examples are misleading in detail.

The program for documenting the fauna of Victoria was planned beyond the issue of the first twenty Decades, as printed plates for further issues are in the collection of Museum Victoria. These plates include figures of additional bryozoan species, largely of the Order Cyclostomata.

Since about 1980, detailed study of bryozoan material using scanning electron microscopy (SEM) has provided information on skeletal details of bryozoans far greater than was previously achieved with drawings or photographs (Bock 1982). It is now clear that many local species which had been identified using the names of European species are quite distinct, and in several cases are actually complexes of several species. In a small number of cases it has also been possible to determine that the species described from Port Phillip include some synonyms. Nevertheless, the work documented in the *Prodromus* remains a remarkably accurate monograph of the local fauna.

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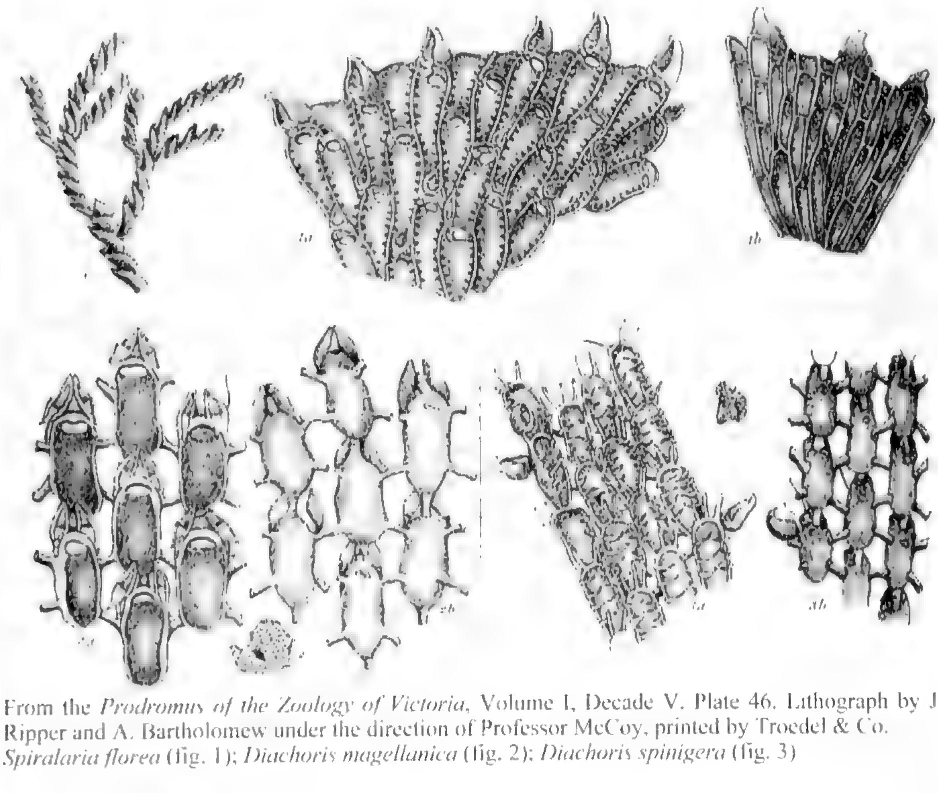

From the *Prodromus of the Zoology of Victoria*, Volume I, Decade V. Plate 46. Lithograph by J. Ripper and A. Bartholomew under the direction of Professor McCoy, printed by Troedel & Co. *Spiralaria florea* (fig. 1); *Diachoris magellanica* (fig. 2); *Diachoris spinigera* (fig. 3)

Table 1. Listing of the bryozoans described in the *Prodromus of the Zoology of Victoria*, with current accepted names for most of the species. In a large number of cases, progress of revision is still inadequate to specify a current name, and the column is left blank. The Location entry is quoted from each entry in the *Prodromus*. Most species are now known to have a wider distribution, although a number have not been recorded in subsequent literature. n.sp., new species, 'PPH', Port Phillip Heads.

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 24, Fig. 1	*Catenicella margaritacea*		*Orthoscuticella margaritacea*	(Busk, 1852)	Vic.
Pl. 24, Fig. 2	*Catenicella plagiostoma*		*Scuticella plagiostoma*	(Busk, 1852)	
Pl. 24, Fig. 3	*Catenicella ventricosa*		*Orthoscuticella ventricosa*	(Busk, 1852)	
Pl. 24, Fig. 4	*Catenicella hastata*		*Costaticella hastata*	(Busk, 1852)	Queenscliff, Western Port
Pl. 24, Fig. 5	*Catenicella rufa*		*Cribricellina rufa*	(MacGillivray, 1869)	
Pl. 24, Fig. 6	*Catenicella cribraria*		*Paracribricellina cribraria*	(Busk, 1852)	Queenscliff, Western Port
Pl. 24, Fig. 7	*Catenicella alata*		*Pterocella vesiculosa*	(Lamarck, 1816)	Queenscliff
Pl. 24, Fig. 8	*Catenicella lorica*		*Orthoscuticella lorica*	(Busk, 1852)	Queenscliff
Pl. 24, Fig. 9	*Catenicella formosa*		*Catenicella formosa*	Busk, 1852	Queenscliff, C.Schanck
Pl. 24, Fig. 10	*Catenicella elegans*		*Catenicella elegans*	Busk, 1852	
Pl. 24, Fig. 11	*Catenicella perforata*		*Cornuticella perforata*	(Busk, 1852)	
Pl. 24, Fig. 12	*Catenicella buskii*		*Catenicella buskii*	Wyville Thomson, 1858	
Pl. 24, Fig. 13	*Catenicella hannafordi*		*Catenicella hannafordi*	MacGillivray, 1869	Portland
Pl. 24, Fig. 14	*Catenicella crystallina*		*Scalicella crystallina*	(W.Thomson, 1858)	
Pl. 24, Fig. 15	*Catenicella carinata*		*Pterocella scutella*	(Hutton, 1891)	
Pl. 24, Fig. 16	*Catenicella aurita*		*Claviporella aurita*	(Busk, 1852)	
Pl. 24, Fig. 17	*Catenicella geminata*		*Claviporella geminata*	(Wyville Thomson, 1858)	
No Fig.	*Catenicella cornuta*		*Cornuticella cornuta*	(Busk, 1852)	
No Fig.	*Catenicella intermedia*		*Orthoscuticella? intermedia*	(MacGillivray, 1869)	
Pl. 25, Fig. 1	*Membranipora membranacea*		*Membranipora membranacea*	(Linnaeus, 1767)	
Pl. 25, Fig. 2	*Membranipora perforata*		*Micropora stenostoma*	(Busk, 1854)	Queenscliff
Pl. 25, Fig. 3	*Membranipora ciliata*		*Chaperia acanthina*	(Lamouroux, 1825)	Queenscliff, Williamstown
Pl. 25, Fig. 4	*Membranipora mamillaris*		*Thairopora mamillaris*	(Lamouroux, 1816) ?	Queenscliff
Pl. 25, Fig. 5,6	*Membranipora umbonata*				Queenscliff
Pl. 25, Fig. 7	*Membranipora pilosa*		*Electra pilosa*	(Linnaeus, 1767)	
Pl. 25, Fig. 8	*Membranipora cervicornis*		*Chaperiopsis cervicornis*	(Busk, 1854)	Williamstown
Pl. 26, Fig. 1	*Membranipora dispar*		*Thairopora dispar*	(MacGillivray, 1869)	Portland
Pl. 26, Fig. 2	*Membranipora woodsii*		*Diploporella woodsii?*	(MacGillivray, 1869)	Portland
Pl. 26, Fig. 3	*Membranipora lineata*		*Valdemunitella pyrula*	(Hincks, 1881)	Schnapper Point, Port Fairy
Pl. 26, Fig. 4	*Membranipora rosselii*				
Pl. 26, Fig. 5,6	*Membranipora lacroixii*		*Conopeum aciculatum*	(MacGillivray, 1891)	Queenscliff, Point Cook, Brighton
Pl. 35, Fig. 1	*Lepralia circinata*		*Phonicosia circinata*	(MacGillivray, 1869)	Queenscliff
Pl. 35, Fig. 2	*Lepralia cecilii*		*Arthropoma cecilii*	(Audouin, 1826)	Queenscliff, Warrnambool
Pl. 35, Fig. 3	*Lepralia diaphana*	n.sp.	*Escharella diaphana*	(MacGillivray, 1879)	Queenscliff, Warrnambool
Pl. 35, Fig. 4	*Lepralia marsupium*		*Aimulosia marsupium*	(MacGillivray, 1869)	
Pl. 35, Fig. 5	*Lepralia subimmersa*	n.sp.	*Calyptotheca subimmersa*	(MacGillivray, 1879)	Warrnambool
Pl. 35, Fig. 6	*Lepralia anceps*	n.sp.	*Calyptotheca anceps*	(MacGillivray, 1879)	Warrnambool

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 35, Fig. 7	*Lepralia maplestonei*	n.sp.	*Schizosmittina maplestonei*	(MacGillivray, 1879)	Williamstown
Pl. 36, Fig. 1	*Lepralia vittata*		*Chorizopora vittata*	(MacGillivray, 1869)	Western Port
Pl. 36, Fig. 2	*Lepralia brogniartii*		*Chorizopora brongniartii*	(Audouin, 1826)	Queenscliff
Pl. 36, Fig. 3	*Membranipora perforata*		*Micropora stenostoma*	(Busk, 1854)	
Pl. 36, Fig. 4	*Lepralia elegans*		*Hippoporina elegans*	(MacGillivray, 1860)	Williamstown, Queenscliff
Pl. 36, Fig. 5,6	*Lepralia pertusa*				Hobsons Bay
Pl. 36, Fig. 7	*Lepralia malusii*				Queenscliff
Pl. 36, Fig. 8	*Lepralia lunata*		*Calloporina lunata*	(MacGillivray, 1860)	Queenscliff
Pl. 37, Fig. 1	*Lepralia ciliata*				Port Fairy, Warrnambool
Pl. 37, Fig. 2	*Lepralia trifolium*		*Onychoblestrum propinquum*	(Waters, 1885)	Queenscliff, Williamstown, Western Port
Pl. 37, Fig. 3	*Lepralia cheilodon*		*Parasmittina cheilodon*	(MacGillivray, 1869)	Williamstown
Pl. 37, Fig. 4	*Lepralia canaliculata*		*Calloporina canaliculata*	(MacGillivray, 1860)	Queenscliff
Pl. 37, Fig. 5	*Lepralia larvalis*		*Didymosella larvalis*	(MacGillivray, 1869)	Williamstown
Pl. 37, Fig. 6	*Lepralia diadema*		*Calloporina diadema*	(MacGillivray, 1869)	Williamstown, Queenscliff, Warrnambool
Pl. 37, Fig. 7	*Lepralia papillifera*		*Smittina papillifera*	(MacGillivray, 1869)	Williamstown
Pl. 37, Fig. 8	*Lepralia ellerii*		*Microporetratiella ellerii*	(MacGillivray, 1869)	Williamstown, Warrnambool
Pl. 38, Fig. 1,2	*Lepralia monoceros*		*Arachnopusia unicornis*	(Hutton, 1873)	Queenscliff, Warrnambool
Pl. 38, Fig. 3	*Lepralia excavata*		*Escharoides excavata*	(MacGillivray, 1860)	Queenscliff
Pl. 38, Fig. 4	*Lepralia vitrea*	n.sp.	*Schizosmittina vitrea*	(MacGillivray, 1879)	Williamstown
Pl. 38, Fig. 5	*Lepralia megasoma*		*Turbicellepora megasoma*	(MacGillivray, 1869)	Queenscliff
Pl. 38, Fig. 6	*Lepralia schizostoma*		*Stylopoma schizostoma*	(MacGillivray, 1869)	Williamstown, Queenscliff
Pl. 38, Fig. 7	*Lepralia botryoides*	n.sp.	*Schizosmittina vitrea*	(MacGillivray, 1879)	Williamstown
Pl. 38, Fig. 8	*Lepralia ferox*		*Hiantopora ferox*	(MacGillivray, 1869)	Williamstown, Queenscliff
Pl. 38, Fig. 9	*Lepralia pellucida*	n.sp.			Williamstown, Queenscliff
Pl. 39, Fig. 1	*Crisia edwardsiana*		*Bicrisia edwardsiana*	(d'Orbigny, 1847)	Williamstown
Pl. 39, Fig. 2	*Crisia biciliata*		*Bicrisia biciliata*	(MacGillivray, 1869)	Williamstown, Warrnambool
Pl. 39, Fig. 3	*Crisia acropora*		*Crisia acropora*	Busk, 1852	Williamstown, Queenscliff
Pl. 39, Fig. 4	*Crisia setosa*		*Crisia setosa*	MacGillivray, 1869	Williamstown, Queenscliff
Pl. 39, Fig. 5	*Crisia tenuis*	n.sp.	*Crisia tenuis*	MacGillivray, 1879	Queenscliff
Pl. 45, Fig. 1	*Flustra denticulata*		*Hincksinoflustra denticulata*	(Busk, 1852)	Queenscliff
Pl. 45, Fig. 2	*Carbasea episcopalis*		*Euthyroides episcopalis*	(Busk, 1852)	Queenscliff, King I.
Pl. 45, Fig. 3	*Carbasea dissimilis*		*Bugularia dissimilis*	(Busk, 1852)	Queenscliff, King I.
Pl. 45, Fig. 4	*Carbasea indivisa*		*Carbasea indivisa*	Busk, 1852	Queenscliff, Portland
Pl. 45, Fig. 5	*Carbasea elegans*		*Carbasea elegans*	Busk, 1852	Queenscliff, Portland
Pl. 45, Fig. 6	*Carbasea pisciformis*		*Carbasea pisciformis*	Busk, 1852	Queenscliff, Portland
Pl. 46, Fig. 1	*Spiralaria florea*		*Spiralaria florea*	Busk, 1861	Queenscliff
Pl. 46, Fig. 2	*Diachoris magellanica*		*Beania magellanica*	(Busk, 1852)	Portland
Pl. 46, Fig. 3	*Diachoris spinigera*		*Beania spinigera*	(MacGillivray, 1860)	Queenscliff, Portland
Pl. 46, Fig. 4	*Dimetopia spicata*		*Dimetopia barbata*	(Lamouroux, 1816)	Queenscliff, Portland
Pl. 46, Fig. 5	*Dimetopia cornuta*		*Dimetopia cornuta*	Busk, 1852	Queenscliff, Portland
Pl. 46, Fig. 6	*Didymia simplex*		*Didymozoum simplex*	(Busk, 1852)	Queenscliff, Portland

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 46, Fig. 7	*Calwellia bicornis*		*Calwellia bicornis*	(Wyville Thomson, 1858)	Queenscliff
Pl. 47, Fig. 1	*Dictyopora cellulosa*		*Adeona cellulosa*	(MacGillivray, 1869)	Queenscliff
Pl. 48, Fig. 1	*Eschara obliqua*		*Parmularia reniformis (?)*	(Kirchenpauer, 1869)	Schnapper Point
Pl. 48, Fig. 2	*Eschara dispar*		*Laminopora dispar*	(MacGillivray, 1869)	Queenscliff
Pl. 48, Fig. 3	*Eschara gracilis*		*Porina gracilis*	(Lamarck, 1816)	Queenscliff
Pl. 48, Fig. 4	*Eschara platalea*		*Adeonella lichenoides*	(Lamarck, 1816)	Queenscliff
Pl. 48, Fig. 5	*Eschara quadrata*	n.sp.	*Emballotheca quadrata*	(MacGillivray, 1880)	Queenscliff, Portland
Pl. 48, Fig. 6,7	*Eschara mucronata*		*Adeonellopsis sulcata*	(Milne Edwards, 1836)	Queenscliff, Schnapper Point
Pl. 48, Fig. 8	*Caleschara denticulata*		*Caleschara denticulata*	(MacGillivray, 1869)	Queenscliff, Schnapper Point
Pl. 49, Fig. 1	*Cellaria fistulosa* var. *australis*	n.var.	*Cellaria australis*	MacGillivray, 1880	Queenscliff, Portland
Pl. 49, Fig. 2	*Cellaria hirsuta*		*Cellaria pilosa*	(Kirchenpauer, 1869)	Queenscliff, Portland
Pl. 49, Fig. 3	*Cellaria tenuirostris*		*Cellaria tenuirostris*	(Busk, 1852)	Queenscliff, Wilsons Prom.
Pl. 49, Fig. 4	*Cellaria gracilis*				Queenscliff, Wilsons Prom.
Pl. 49, Fig. 5	*Nellia oculata*		*Nellia tenella*	(Lamarck, 1816)	Queenscliff
Pl. 49, Fig. 6	*Tubucellaria hirsuta*		*Margaretta barbata*	(Lamarck, 1816)	Queenscliff, Portland
Pl. 57, Fig. 1	*Biflustra perfragilis*	n.n.	*Biflustra perfragilis*	MacGillivray, 1881	PPH, King I.
Pl. 57, Fig. 2	*Biflustra delicatula*		*Biflustra savartii*	(Audouin, 1826)	Queenscliff
Pl. 58, Fig. 1	*Cellularia cuspidata*		*Bugulopsis monotrypa*	(Busk, 1852)	Queenscliff
Pl. 58, Fig. 2	*Menipea crystallina*		*Emma rotunda*	Hastings, 1939	Queenscliff
Pl. 58, Fig. 3	*Menipea cyathus*		*Monartron cyathus*	(Wyville Thomson, 1858)	Queenscliff
Pl. 58, Fig. 4	*Menipea cervicornis*		*Emma cervicornis*	(MacGillivray, 1869)	Queenscliff
Pl. 58, Fig. 5	*Menipea tricellata*		*Emma tricellata*	Busk, 1852	Queenscliff
Pl. 58, Fig. 6	*Menipea buskii*		*Emma buskii*	(Wyville Thomson, 1858)	Queenscliff
Pl. 59, Fig. 1	*Bicellaria tuba*		*Cornucopina tuba*	(Busk, 1852)	Queenscliff, Portland
Pl. 59, Fig. 2,3	*Bicellaria grandis*		*Cornucopina grandis*	(Busk, 1852)	Queenscliff, C.Otway
Pl. 59, Fig. 4	*Bicellaria ciliata*		*Bicellariella ciliata*	(Linnaeus, 1758)	Queenscliff, Portland
Pl. 59, Fig. 5	*Bicellaria turbinata*		*Bicellariella turbinata*	(MacGillivray, 1869)	Queenscliff
Pl. 59, Fig. 6	*Stirparia annulata*		*Caulibugula annulata*	(Maplestone, 1879)	C.Otway, Portland
Pl. 59, Fig. 7	*Bugula neritina*		*Bugula neritina*	(Linnaeus, 1758)	Hobsons Bay, Queenscliff, Warrnambool
Pl. 60, Fig. 1	*Steganoporella magnilabris*		*Steginoporella truncata*	Harmer, 1900	Queenscliff, Portland
Pl. 60, Fig. 2	*Petralia undata*		*Petralia undata*	(MacGillivray, 1869)	Queenscliff, Portland
Pl. 66, Fig. 1	*Dictyopora grisea*		*Adeona grisea*	Lamouroux, 1816	PPH
Pl. 66, Fig. 2	*Dictyopora albida* var. *avicularis*		*Adeona albida*	Kirchenpauer, 1880	PPH
Pl. 67.	*Dictyopora wilsoni*		*Adeona wilsoni*	(MacGillivray, 1881)	PPH
Pl. 68, Fig. 1	*Idmonea milneana*				PPH
Pl. 68, Fig. 2	*Idmonea australis*	n.sp.	*Idmidronea australis*	(MacGillivray, 1882)	PPH
Pl. 68, Fig. 3	*Idmonea radians*		*Mesonea radians*	(Lamarck, 1816)	Queenscliff, Williamstown, Portland
Pl. 78, Fig. 1	*Bugula robusta*		*Bugula robusta*	MacGillivray, 1869	Western Port
Pl. 78, Fig. 2	*Bugula cucullata*		*Bugula cucullata*	Busk, 1867	Queenscliff, Portland
Pl. 78, Fig. 3	*Bugula dentata*		*Bugula dentata*	(Lamouroux, 1816)	Queenscliff, Hobsons Bay

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 78, Fig. 4	*Bugula avicularia*		*Bugula avicularia*	(Linnaeus, 1758)	Hobsons Bay
Pl. 89, Fig. 1	*Catenicella intermedia*		*Orthoscuticella? intermedia*	(MacGillivray, 1869)	PPH
Pl. 89, Fig. 2	*Catenicella amphora*		*Orthoscuticella amphora*	(Busk, 1852)	PPH
Pl. 89, Fig. 3	*Catenicella wilsoni*		*Orthoscuticella wilsoni*	(MacGillivray, 1881)	PPH
Pl. 89, Fig. 4	*Catenicella pulchella*		*Strongylopora pulchella*	(Maplestone, 1880)	PPH, Queenscliff
Pl. 89, Fig. 5	*Catenicella utriculus*	n.sp.	*Catenicella utriculus*	MacGillivray, 1884	Warrnambool
Pl. 90, Fig. 1	*Catenicella fusca*	n.sp.	*Catenicella fusca*	MacGillivray, 1884	Queenscliff
Pl. 90, Fig. 2	*Catenicella umbonata*		*Scalicella umbonata*	(Busk, 1852)	PPH
Pl. 90, Fig. 3	*Catenicella cornuta*		*Cornuticella cornuta*	(Busk, 1852)	Queenscliff
Pl. 94.	*Opercula of Retepora spp.*				
Pl. 95, Fig. 1-6	*Retepora porcellana*		*Reteporella porcellana*	(MacGillivray, 1869)	PPH
Pl. 95, Fig. 7-11	*Retepora avicularis*		*Phidolopora avicularis*	(MacGillivray, 1883)	PPH
Pl. 95, Fig. 12-16	*Retepora fissa*		*Reteporella fissa*	(MacGillivray, 1869)	
Pl. 96, Fig. 1-3	*Retepora monilifera* form *monilifera*		*Triphyllozoon moniliferum*	(MacGillivray, 1860)	PPH, Portland, Warrnambool
Pl. 96, Fig. 4-8	*Retepora monilifera* form *munita*		*Triphyllozoon munitum*	(Hincks, 1878)	
Pl. 97, Fig. 1-3	*Retepora monilifera* form *umbonata*		*Triphyllozoon munitum*	(Hincks, 1878)	PPH
Pl. 97, Fig. 4-6	*Retepora formosa*		*Triphyllozoon formosum*	(MacGillivray, 1884)	PPH
Pl. 97, Fig. 7	*Retepora carinata*		*Reteporella carinata*	(MacGillivray, 1884)	PPH
Pl. 98, Fig. 1-5	*Retepora phoenicea*		*Iodictyum phoeniceum*	(Busk, 1854)	PPH, Portland, King I.
Pl. 98, Fig. 6-7	*Retepora aurantiaca*		*Reteporella aurantiaca*	(MacGillivray, 1883)	PPH
Pl. 99, Fig. 1-3	*Retepora granulata*		*Reteporella granulata*	(MacGillivray, 1869)	PPH
Pl. 99, Fig. 4-8	*Retepora tessellata*		*Schizoretepora tessellata*	(Hincks, 1878)	PPH
Pl. 99, Fig. 9	*Retepora serrata*		*Iodictyum serratum*	(MacGillivray, 1883)	PPH
Pl. 105, Fig. 1	*Cellaria rigida*		*Cellaria rigida*	MacGillivray, 1885	PPH
Pl. 105, Fig. 2	*Tubucellaria cereoides*		*Margaretta watersi*	(Canu & Bassler, 1930)	PPH
Pl. 105, Fig. 3-4	*Urceolipora dentata*		*Malakosaria dentata*	(MacGillivray, 1885)	PPH
Pl. 105, Fig. 5-7	*Urceolipora nana*		*Urceolipora nana*	MacGillivray, 1881	PPH
Pl. 106, Fig. 1	*Amphiblestrum punctigerum*				PPH
Pl. 106, Fig. 2	*Amphiblestrum flemingii*				PPH
Pl. 106, Fig. 3	*Amphiblestrum perminutum*		*Parellisina falcata*	(MacGillivray, 1869)	PPH, Portland
Pl. 106, Fig. 4	*Pyripora crassa*		*Mychoplectra crassa*	(MacGillivray, 1869)	Queenscliff
Pl. 106, Fig. 5	*Pyripora catenularia*		*Mychoplectra crassa*	(MacGillivray, 1869)	PPH, Brighton
Pl. 106, Fig. 6	*Pyripora polita*		*Mychoplectra pocula*	(Hincks, 1880)	Queenscliff
Pl. 106, Fig. 7	*Electra flagellum*		*Electra flagellum*	(MacGillivray, 1882)	Queenscliff
Pl. 106, Fig. 8	*Bathypora porcellana*		*Bathypora porcellana*	(MacGillivray, 1885)	Portland
Pl. 106, Fig. 9	*Biflustra papulifera*		*Crassimarginatella papulifera*	(MacGillivray, 1882)	PPH
Pl. 106, Fig. 10	*Biflustra bimamillata*				
Pl. 107, Fig. 1	*Catenicellopsis pusilla*		*Claviporella pusilla*	(Wilson, 1880)	Spring Ck (Geelong)
Pl. 107, Fig. 2	*Catenicellopsis delicatula*		*Catenicellopsis delicatula*	(Wilson, 1880)	PPH, Spring Ck (Geelong)
Pl. 107, Fig. 3	*Calpidium ponderosum*		*Calpidium ponderosum*	(Goldstein, 1880)	PPH
Pl. 108, Fig. 1	*Calpidium ornatum*		*Calpidium ornatum*	Busk, 1852	PPH

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 108, Fig. 2	*Chlidonia daedala*		*Chlidonia pyriformis*	(Bertolini, 1810)	
Pl. 116, Fig. 1	*Beania mirabilis*		*Beania mirabilis*	Johnston, 1840	PPH
Pl. 116, Fig. 2,4	*Mucronella tricuspis*		*Exochella tricuspis*	(Hincks, 1881)	PPH, Portland
Pl. 116, Fig. 3	*Mucronella laevis*		*Escharella teres*	(Hincks, 1881)	PPH
Pl. 116, Fig. 5-8	*Mucronella vultur*		*Mucropetraliella vultur*	(Hincks, 1882)	PPH, Portland, Warrnambool
Pl. 116, Fig. 9	*Cyclicopora longipora*		*Cyclicopora longipora*	(MacGillivray, 1883)	PPH
Pl. 117, Fig. 1,2	*Beania decumbens*		*Beania decumbens*	MacGillivray, 1882	PPH
Pl. 117, Fig. 3	*Beania costata*		*Beania discodermiae*	(Ortmann, 1890)	PPH
Pl. 117, Fig. 4,5	*Beania crotali*		*Beania crotali*	(Busk, 1852)	PPH, Portland
Pl. 117, Fig. 6-8	*Beania radicifera*		*Hiantopora radicifera*	(Hincks, 1881)	PPH
Pl. 117, Fig. 9	*Amphiblestrum patellarium*		*Mollia patellaria*	(Moll, 1803)	PPH
Pl. 118, Fig. 1-5	*Hornera foliacea*		*Hornera foliacea*	(MacGillivray, 1869)	PPH, Portland, Western Port
Pl. 118, Fig. 6-8	*Hornera robusta*		*Hornera robusta*	(MacGillivray, 1869)	PPH
Pl. 126, Fig. 1	*Maplestonia cirrata*		*Maplestonia cirrata*	MacGillivray, 1885	PPH, Portland, Warrnambool
Pl. 126, Fig. 3	*Scrupocellaria cyclostoma*		*Scrupocellaria cyclostoma*	Busk, 1852	PPH, Portland
Pl. 126, Fig. 4-5	*Scrupocellaria obtecta*				PPH
Pl. 126, Fig. 6-7	*Scrupocellaria cervicornis*				PPH
Pl. 126, Fig. 8	*Scrupocellaria scrupea*				PPH, Portland
Pl. 126, Fig. 9	*Scrupocellaria ornithorhynchus*		*Scrupocellaria ornithorhynchus*	Thomson, 1858	PPH
Pl. 127, Fig. 1	*Membranipora pyrula*		*Valdemunitella pyrula*	(Hincks, 1881)	PPH, Portland
Pl. 127, Fig. 2	*Membranipora corbula*		*Corbulella corbula*	(Hincks, 1880)	PPH, Portland
Pl. 127, Fig. 3	*Membranipora inarmata*		*Gregarinidra inarmata*	(Hincks, 1881)	PPH
Pl. 127, Fig. 4	*Membranipora pectinata*		*Gregarinidra inarmata*	(Hincks, 1881)	PPH
Pl. 127, Fig. 5	*Membranipora serrata*		*Gregarinidra serrata*	(MacGillivray, 1869)	PPH
Pl. 127, Fig. 6	*Membranipora ciliata*		*Chaperia acanthina*	(Lamouroux, 1825)	Portland
Pl. 127, Fig. 7	*Amphiblestrum albispinum*		*Chaperia albispina*	(MacGillivray, 1882)	Queenscliff, Portland
Pl. 127, Fig. 8	*Membranipora spinosa*		*Chaperia acanthina*	(Lamouroux, 1825)	
Pl. 128, Fig. 1	*Cellepora speciosa*	n.sp.	*Celleporaria speciosa*	(MacGillivray, 1886)	PPH
Pl. 128, Fig. 2	*Cellepora serratirostris*		*Celleporaria serratirostris*	(MacGillivray, 1885)	PPH
Pl. 128, Fig. 3	*Cellepora tridenticulata*				PPH, Warrnambool
Pl. 136, Fig. 1	*Caberea rudis*		*Amastigia rudis*	Busk, 1852	PPH, Portland
Pl. 136, Fig. 2	*Caberea grandis*		*Caberea dichotoma*	Lamouroux, 1816	PPH
Pl. 136, Fig. 3	*Canda arachnoides*		*Canda arachnoides*	Lamouroux, 1816	PPH, Portland
Pl. 136, Fig. 4	*Canda tenuis*		*Canda tenuis*	MacGillivray, 1885	PPH
Pl. 137, Fig. 1,5	*Caberea darwinii*		*Caberea helicina*	Hastings, 1943	PPH, Portland
Pl. 137, Fig. 2-4	*Caberea glabra*		*Caberea glabra*	MacGillivray, 1886	PPH
Pl. 137, Fig. 6	*Aetea dilatata*		*Aetea dilatata*	(Busk, 1851)	PPH
Pl. 137, Fig. 7	*Aetea anguina*		*Aetea anguina*	(Linnaeus, 1758)	PPH
Pl. 138, Fig. 1	*Schizoporella punctigera*		*Parkermavella punctigera*	(MacGillivray, 1883)	PPH
Pl. 138, Fig. 2	*Schizoporella lata*				PPH
Pl. 138, Fig. 3	*Schizoporella triangula*		*Calyptotheca triangula*	(Hincks, 1881)	PPH

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 138, Fig. 4	*Schizoporella daedala*		*Chiastosella daedala*	(MacGillivray, 1887)	
Pl. 138, Fig. 5	*Schizoporella subsinuata*				PPH
Pl. 138, Fig. 6,7	*Schizoporella ridleyi*		*Buffonellodes ridleyi*	(MacGillivray, 1883)	PPH
Pl. 138, Fig. 8	*Schizoporella arachnoides*		*Lacerna arachnoides*	(MacGillivray, 1883)	PPH
Pl. 138, Fig. 9	*Schizoporella cryptostoma*		*Stephanollona cryptostoma*	(MacGillivray, 1885)	PPH
Pl. 138, Fig. 10	*Gemellipora striatula*		*Trypostega venusta*	(Norman, 1864)	PPH
Pl. 146, Fig. 1	*Catenicella gemella*		*Pterocella gemella*	(MacGillivray, 1887)	PPH
Pl. 146, Fig. 2	*Catenicella urnula*		*Orthoscuticella urnula*	(MacGillivray, 1887)	PPH
Pl. 146, Fig. 3	*Catenicella gracilenta*				PPH
Pl. 146, Fig. 4	*Catenicella venusta*		*Catenicella venusta*	MacGillivray, 1887	PPH
Pl. 146, Fig. 5	*Catenicella pulchra*				PPH
Pl. 146, Fig. 6	*Catenicella imperforata*				PPH
Pl. 147, Fig. 1	*Diastopora cristata*				PPH
Pl. 147, Fig. 2	*Diastopora capitata*				PPH
Pl. 147, Fig. 3	*Diastopora bicolor*				PPH
Pl. 147, Fig. 4	*Diastopora sarmensis*		*Plagioecia sarmensis*	(Norman, 1864)	PPH
Pl. 147, Fig. 5	*Diastopora patina*		*Plagioecia patina*	(Lamarck, 1816)	PPH
Pl. 148, Fig. 1	*Cellepora megasoma*		*Turbicellepora redoutei*	(Audouin, 1826)	PPH
Pl. 148, Fig. 2	*Cellepora costata*		*Celleporina costata*	(MacGillivray, 1869)	PPH, Portland, Warrnambool, Wilsons Prom.
Pl. 148, Fig. 3	*Cellepora rota*				PPH
Pl. 148, Fig. 5-6	*Cellepora costazei* var. *spatula*	*n.var*	*Celleporina spatula*	(MacGillivray, 1887)	PPH
Pl. 148, Fig. 7	*Cellepora platalea*		*Celleporina platalea*	(MacGillivray, 1869)	PPH
Pl. 148, Fig. 8	*Cellepora glomerata*		*Osthimosia glomerata?*	(MacGillivray, 1887)	PPH
Pl. 148, Fig. 9	*Cellepora vitrea*				PPH
Pl. 148, Fig. 10	*Cellepora tiara*				PPH
Pl. 148, Fig. 11	*Cellepora benemunita*	n.sp	*Osthimosia benemunita*	(MacGillivray, 1887)	PPH
Pl. 156, Fig. 1,2	*Lagenipora tuberculata*		*Exechonella tuberculata*	(MacGillivray, 1883)	PPH
Pl. 156, Fig. 3	*Lagenipora nitens*		*Celleporina platalea*	(MacGillivray, 1869)	PPH
Pl. 156, Fig. 4-10	*Lekythopora hystrix*		*Lekythopora hystrix*	MacGillivray, 1883	PPH
Pl. 156, Fig. 11-13	*Poecilopora anomola*		*Poecilopora anomala*	MacGillivray, 1886	PPH
Pl. 157, Fig. 1	*Fasciculipora gracilis*		*Hastingsia gracilis*	(MacGillivray, 1883)	PPH
Pl. 157, Fig. 2	*Fasciculipora bellis*				PPH
Pl. 157, Fig. 3	*Fasciculipora fruticosa*				PPH
Pl. 157, Fig. 4	*Fasciculipora ramosa*				Portland
Pl. 158, Fig. 1	*Farciminaria aculeata*		*Farciminaria aculeata*	Busk, 1852	PPH
Pl. 158, Fig. 2-4	*Farciminaria uncinata*		*Farciminaria uncinata*	Hincks, 1884	PPH
Pl. 158, Fig. 5	*Farciminaria simplex*		*Farciminaria simplex*	MacGillivray, 1886	PPH
Pl. 158, Fig. 6-8	*Bracebridgia pyriformis*		*Bracebridgia pyriformis*	(Busk, 1884)	
Pl. 165, Fig. 1	*Cellepora simplex*	n.sp	*Celleporaria simplex*	(MacGillivray, 1888)	PPH

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 165, Fig. 2	*Cellepora diadema*	n.sp			PPH
Pl. 165, Fig. 3	*Cellepora spicata*	n.sp	*Celleporaria spicata*	(MacGillivray, 1888)	PPH
Pl. 165, Fig. 4	*Cellepora cidaris*	n.sp	*Celleporaria columnaris*	(Busk, 1881)	PPH
Pl. 165, Fig. 5	*Cellepora bispinata*		*Celleporaria bispinata*	(Busk, 1854)	PPH, Warrnambool, Portland
Pl. 166, Fig. 1	*Cellepora verrucosa*	n.sp.	*Celleporaria verrucosa*	(MacGillivray, 1888)	Portland
Pl. 166, Fig. 2	*Cellepora foliata*	n.sp	*Celleporaria foliata*	(MacGillivray, 1888)	Portland
Pl. 166, Fig. 3	*Cellepora intermedia*		*Celleporaria intermedia*	(MacGillivray, 1869)	Queenscliff
Pl. 166, Fig. 4	*Cellepora prolifera*	n.sp	*Celleporaria prolifera*	(MacGillivray, 1888)	Portland
Pl. 167, Fig. 1	*Cellepora albirostris*				PPH
Pl. 167, Fig. 2	*Cellepora fusca*		*Celleporaria fusca*	(Busk, 1854)	Portland
Pl. 167, Fig. 3	*Cellepora lirata*	n.sp	*Celleporaria cristata*	(Lamarck, 1816)	PPH
Pl. 167, Fig. 4	*Cellepora magnirostris*	n.sp	*Celleporaria magnirostris*	(MacGillivray, 1888)	PPH
Pl. 168.	Chitinous parts of *Cellepora* spp.				
Pl. 175, Fig. 1	*Tessaradoma magnirostris*		*Tubiporella magnirostris*	(MacGillivray, 1883)	PPH
Pl. 175, Fig. 2	*Microporella diadema* var. *lunipuncta*		*Calloporina lunipuncta*	(MacGillivray, 1885)	
Pl. 175, Fig. 3	*Microporella diadema* var. *longispina*				
Pl. 175, Fig. 4	*Microporella diadema* var. *lata*		*Calloporina lunata*	(MacGillivray, 1860)	
Pl. 175, Fig. 5	*Microporella diadema* var. *canaliculata canaliculata*		*Calloporina canaliculata*	(MacGillivray, 1860)	
Pl. 175, Fig. 6	*Microporella renipuncta*		*Calloporina renipuncta*	(MacGillivray, 1883)	PPH
Pl. 175, Fig. 7	*Microporella scandens*		*Calwellia?*		PPH
Pl. 175, Fig. 8	*Microporella ciliata* var. *spicata*				
Pl. 175, Fig. 9	*Microporella ciliata* var. *personata*				
Pl. 175, Fig. 10	*Microporella malusii* var. *personata*				
Pl. 175, Fig. 11	*Microporella malusii* var. *thyreophora*				
Pl. 175, Fig. 12	*Escharipora stellata*		*Triporula biarmata*	(Waters, 1882)	PPH
Pl. 176, Fig. 1	*Stomatopora geminata*		*Stomatopora geminata*	MacGillivray, 1887	
Pl. 176, Fig. 2	*Flosculipora pygmaea*		*Flosculipora pygmaea*	MacGillivray, 1887	PPH
Pl. 176, Fig. 3	*Lichenopora magnifica*				PPH
Pl. 176, Fig. 4	*Lichenopora bullata*		*Disporella bullata*	(MacGillivray, 1887)	PPH, Warrnambool, Portland
Pl. 177, Fig. 1,2	*Craspedozoum ligulatum*		*Menipea ligulata*	(MacGillivray, 1886)	PPH
Pl. 177, Fig. 3	*Craspedozoum spicatum*		*Menipea spicata*	(MacGillivray, 1886)	PPH
Pl. 177, Fig. 4,5	*Craspedozoum roboratum*		*Menipea roborata*	(Hincks, 1881)	PPH
Pl. 177, Fig. 6	*Menipea funiculata*		*Amastigia funiculata*	(MacGillivray, 1886)	PPH
Pl. 178, Fig. 1	*Aetea recta*		*Aetea sica*	(Couch, 1844)	PPH
Pl. 178, Fig. 2,3	*Scruparia chelata*		*Scruparia ambigua*	(d'Orbigny, 1847)	PPH
Pl. 178, Fig. 4,5	*Rhabdozoum wilsoni*		*Rhabdozoum wilsoni*	(Hincks, 1882)	PPH
Pl. 178, Fig. 6	*Farcimia appendiculata*		*Nellia appendiculata*	(Hincks, 1883)	PPH
Pl. 178, Fig. 7	*Catenicella ringens*		*Catenicella ringens*	Busk, 1852	PPH
Pl. 178, Fig. 8	*Dimetopia hirta*		*Dimetopia hirta*	MacGillivray, 1886	PPH
Pl. 185, Fig. 1	*Amathia bicornis*		*Amathia acervata*	Lamouroux, 1824	PPH

Plate	Name Used	Remarks	Current Name	Author	Locality
Pl. 185, Fig. 2	*Amathia spiralis*		*Amathia convoluta*	Lamarck, 1816	PPH
Pl. 185, Fig. 3	*Amathia tortuosa*		*Amathia tortuosa*	Tenison Woods, 1880	PPH, Wilsons Prom.
Pl. 185, Fig. 4	*Amathia inarmata*		*Amathia biseriata*	Krauss, 1837	PPH
Pl. 185, Fig. 5	*Amathia australis*		*Amathia woodsii*	(Goldstein, 1879)	PPH
Pl. 186, Fig. 1	*Schizoporella rostrata*		*Bitectipora rostrata*	(MacGillivray, 1887)	PPH
Pl. 186, Fig. 2	*Schizoporella woosteri*		*Stephanollona orbicularis*	(Hincks, 1881)	Queenscliff
Pl. 186, Fig. 3	*Schizoporella pulcherrima*				PPH
Pl. 186, Fig. 4	*Schizoporella latisinuata*				PPH
Pl. 186, Fig. 5	*Schizoporella biturrita*		*Calyptotheca variolosa*	(MacGillivray, 1869)	PPH
Pl. 186, Fig. 6	*Schizoporella pachnoides*		*Metroperiella montferrandi*	(Audouin, 1826)	PPH
Pl. 186, Fig. 7-9	*Schizoporella hyalina*				
Pl. 187, Fig. 1-2	*Membraniporella distans*		*Membraniporella distans*	MacGillivray, 1882	PPH, Warrnambool
Pl. 187, Fig. 3-4	*Cribrilina radiata*				PPH
Pl. 187, Fig. 5	*Cribrilina setirostris*		*Cribralaria setirostris*	(MacGillivray, 1883)	PPH
Pl. 187, Fig. 6	*Cribrilina monoceros*		*Arachnopusia unicornis*	(Hutton, 1873)	PPH, Warrnambool
Pl. 187, Fig. 7	*Cribrilina acanthoceros*		*Arachnopusia acanthoceros*	(MacGillivray, 1887)	PPH
Pl. 187, Fig. 8-9	*Hippothoa divaricata*		*Hippothoa divaricata*	Lamouroux, 1821	PPH, Hobsons Bay
Pl. 187, Fig. 10-13	*Hippothoa distans*		*Hippothoa distans*	(MacGillivray, 1869)	PPH, Hobsons Bay
Pl. 187, Fig. 14	*Electra amplectens*		*Heterooecium amplectens*	(Hincks, 1881)	PPH
Pl. 195, Fig. 1,2	*Stirparia glabra*		*Caulibugula glabra*	(Hincks, 1883)	Lorne
Pl. 195, Fig. 3	*Beania intermedia*		*Beania intermedia*	(Hincks, 1881)	PPH
Pl. 195, Fig. 4	*Beania conferta*		*Beania conferta*	MacGillivray, 1886	PPH, Portland
Pl. 195, Fig. 5	*Beania wilsoni*		*Beania wilsoni*	MacGillivray, 1885	PPH
Pl. 195, Fig. 6	*Verrucularia dichotoma*		*Elzerina blainvillii*	(Lamouroux, 1816)	PPH
Pl. 196, Fig. 1	*Thairopora armata*		*Thairopora armata*	(MacGillivray, 1869)	Queenscliff
Pl. 196, Fig. 2	*Thairopora mamillaris*		*Thairopora mamillaris*	(Lamouroux, 1816) ?	
Pl. 196, Fig. 3	*Thairopora jervoisii*		*Thairopora jervoisii*	(Hincks, 1880)	Sorrento
Pl. 196, Fig. 4-5	*Micropora coriacea*				
Pl. 196, Fig. 6	*Micropora coriacea* var. *angusta*		*Micropora angusta*	MacGillivray, 1887	
Pl. 196, Fig. 7-10	*Rhyncopora bispinosa*				PPH
Pl. 196, Fig. 11-14	*Rhyncopora longirostris*				PPH, Portland, Warrnambool

McCoy's Contribution to Graptolithology

Noel Schleiger[1]

Introduction

This study is confined to Frederick McCoy's publications on the description and occurrence in Victoria of graptolites, as inferred from his various reports in the *Prodromus of Palaeontology of Victoria* 1874-1881. The aim is to relate McCoy's descriptions and concepts to the present-day situation, especially with regard to the advances in graptolite taxonomy over the last 100 years.

In 1854 McCoy was appointed Professor of Natural Science in the University of Melbourne. In 1856 he was appointed Palaeontologist to the Geological Survey of Victoria, and later became Director of the National Museum of Victoria. Therefore, he held these three positions concurrently. Geologists working on the Survey collected specimens which were subsequently housed in the National Museum. McCoy supplied the age determinations most necessary for compiling the Geological Quarter Sheets, and described those fossils for taxonomic determination. McCoy provided this service efficiently until shortly before his death in 1899 (Darragh *et al.* 1976).

McCoy had previously worked with Adam Sedgwick on the graptolites in Scotland, Wales and Ireland, and was aware of collections from Sweden, Bohemia and Canada.

McCoy's work in the *Prodromus*

Brough Smyth was appointed Secretary for Mines in Victoria in 1860. He instituted several important geological publications, such as the Reports of Mining Surveyors and Registrars which recorded significant data on the Victorian Goldfields. He also supported Frederick McCoy's *Prodromus of the Palaeontology of Victoria*, which was issued in seven parts between 1874 and 1882.

The idea was to produce *Memoirs of the National Museum*, and *Prodromus* was the start. Darragh *et al.* (1976) rate this work as one of the finest Australian palaeontological publications. Of the eleven taxonomic fossil groups, graptolites ranked second in the number of species described by McCoy in the various decades of the *Prodromus* (1874-1881).

In Decade I in his discussion of the graptolites he regards these fossils as very important in the dating of the Lower Silurian (now Ordovician), especially the gold deposits of Victoria.

Table 1 shows the graptolites in Decades I, II and V, making 19 species in all which he described in the *Prodromus*.

Early discovery of graptolites in Victoria

Darragh *et al.* (1976) report that the first Silurian graptolites came from Keilor in May 1856, found by Selwyn and Aplin, whilst the first from the Ordovician were found by Thureau at Bendigo in 1857. J.H. Panton, Warden of the Bendigo Goldfield, gave McCoy graptolite specimens from Bird Reef, Bendigo in 1858. From these collections McCoy realised that graptolites were world-wide in their distribution and not just in the northern hemisphere in the Ordovician period. He was most impressed when he found that the very same graptolite species at Bendigo also occurred in the old goldmines at Gogofau in Wales (McCoy 1874).

Evolution of graptolite taxonomy

Uniserial forms

It is interesting to read McCoy's report of the first Lower Ordovician graptolites from Bendigo. It makes one appreciate how the taxonomy and terminology has changed and developed from these first descriptions.

In the *Prodromus* (McCoy 1874), the generic name *Graptolites* was applied to all those species having 'one row of cells' (known today as 'thecae'; Fig. 1) on each branch or stem (today referred to as the 'stipe'). If the polypidium – the whole body of the fossil (today known as the 'rhabdo-

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Table 1. Graptolites described by McCoy in the various decades of the *Prodromus of the Palaeontology of Victoria.*

Decade No.	Plate No.	Figure No.	Genus or Sub-genus	Species	Age Today
I	I	1-4	*Phyllograptus*	*folium* var. *typus*	Bendigonian
		5	*Diplograpsus*	*mucronatus*	Llandeilo
		6	*Diplograpsus*	*pristis*	Llandeilo
		7	*Diplograpsus*	*rectangularis*	Llandeilo
		8	*Diplograpsus (Climacograpsus)*	*bicornis*	Llandeilo
		9-14	*Graptolites (Didymograpsus)*	*fruticosus* (Hall)	Bendigonian
	II	1	*Graptolites (Didymograpsus)*	*quadribrachiatus* (Hall)	Bendigonian
		2,3,5	*Graptolites (Didymograpsus)*	*bryonoides*	Lower to Middle Ordovician
		4	*Graptolites (Didymograpsus)*	*octobrachiatus*	Castlemainian
		6	*Graptolites (Didymograpsus)*	*logani* (Hall) var. *australis* (McCoy)	Castlemainian
II	XX	1	*Graptolites (Didymograpsus)*	*extensus* (Hall)	Lower Ordovician
		3-5	*Graptolites (Didymograpsus)*	*caduceus* (Salter)	Castlemainian (Lower Ordovician)
		6	*Diplograpsus*	*palmeus* (Barrande)	Upper Ordovician
		2	*Cladograpsus*	*ramosus* (Hall)	Upper Ordovician
		7	*Cladograpsus*	*furcatus* (Hall)	Upper Ordovician
		9	*Graptolites (Didymograpsus)*	*gracilis*	Upper Ordovician
		10	*Retiolites*	*australis*	Wenlock (Silurian)
V	L	1-4	*Graptolites (Didymograpsus)*	*thureaui* (McCoy)	Bendigonian (Lower Ordovician)
		5	*Graptolites (Didymograpsus)*	*headi* (Hall)	Castlemainian (Lower Ordovician)

some') – had two simple stems (stipes) united by a slender non-celluliferous base (today, the 'sicula') the subgenus *Didymograpsus* (twin graptolites) was applied.

At this stage of the evolution of the taxonomy, all multi-branched forms were designated *Graptolites (Didymograpsus)* presumably because fragmentary stipes could not be distinguished from part of *Didymograpsus*, or the distal fragment of a many branched form. The species name could be applied to a multi-branched form when the complete specimen was available. In today's taxonomy that species name has often been retained, and this is the best clue to link the terminology of McCoy with that of today. Three examples of the multi-branched forms are shown in Fig. 2.

A feature of the evolution of the *Didymograpsus* subgenus throughout the Lower Ordovician period was to drop the number of stipe dichotomies (stipe orders) from six down to two. Thus, in Fig. 2, *Loganograptus*, with four dichotomies, reduces to three in *Dichograptus* and to two in *Tetragraptus*.

Biserial Forms

The name *Diplograpsus* was applied in the 19th century to those graptolites with 'two rows of cells or denticles'. Before coming to Victoria, McCoy had recorded biserial forms in Britain and Ireland (McCoy 1846; Sedgwick and McCoy 1855), based on Professor Hall's work in Canada, viz: *Diplograpsus foliaceus*

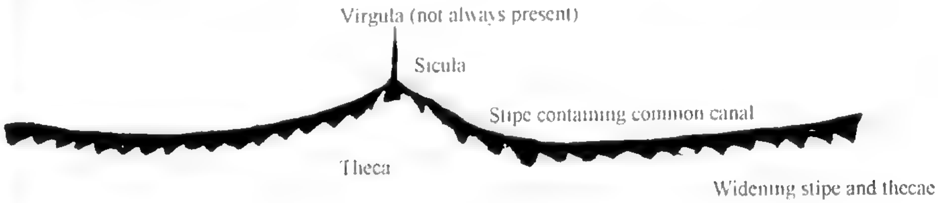

Fig. 1. Graptolite *Didymograpsus extensus* (Hall), today known as *Expansograptus balticus*, a lower Ordovician uniserial form.

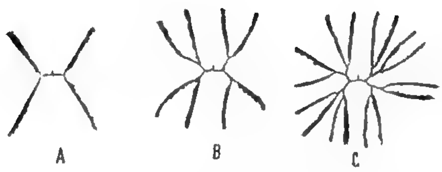

Fig. 2. Three multi-branched graptolites described by McCoy from the Bendigo Goldfields (modern taxonomy in brackets): a. *Graptolites (Didymograpsus) quadribrachiatus* (Hall) (*Tetagraptus quadribrachiatus*); b. *Graptolites (Didymograpsus) octobrachiatus* (Hall) (*Dichograptus octobrachiatus*); c. *Graptolites (Didymograpsus) logani* var. *australis* (*Loganograptus logani*).

(Murchison), *D. folium* (Hisunger), *D. mucronatus* (Hall), *D. pristis* (Hisinger sp.) var. B (Hall), *D. ramosus* (Hall), *D. rectangularis* (McCoy), and *D. ? sextans* (Hall).

McCoy realised that the distinction between *Didymograpsus* and *Diplograpsus* forms was important. However, at this stage it was not realised that the sequence of graptolite forms through the Ordovician succession went from uniserial to biserial and then back to the uniserial condition in the Upper Ordovician succession.

Thus in the bottom third of the Lower Silurian (Llandoverian), biserial forms became extinct and only uniserial forms, usually Monograptidae, existed until the extinction of the graptolites in the Emsian division of the Lower Devonian (Thomas 1960; Cas and VandenBerg 1988; VandenBerg 1988).

The problems with the subgeneric classification of graptolites into *Didymograpsus* were that *Didymograpsus* did not distinguish between the number of stipes in the rhabdosome; also *Didymograpsus* did not differentiate forms which were uniserial in the Lower Ordovician and Upper Ordovician through Silurian to Lower Devonian (Emsian) sequences.

Concepts inferred from McCoy's reports on graptolite taxa

Taxonomy of the graptolites

Features of McCoy's fossil reports were to designate the Class, Order and Family of the fossil under study, together with a brief resume of the taxonomy at that time. This was followed by a detailed description with salient measurements, then by discussion and localities of occurrence.

The well-known Bendigonian zone fossil of today, *Pendeograptus fruticosus*, was described by McCoy (1874) as *Graptolites (Didymograpsus) fruticosus* (Hall).

This was the first Victorian graptolite McCoy was to see when he arrived in Victoria (McCoy 1874). McCoy immediately recognised it as a new species. At that time he named it in his manuscript *Graptolites (Didymograpsus) pantoni* after J.A. Panton, then warden of the Bendigo goldfield. McCoy corresponded with Prof. Hall of Canada, who subsequently had discovered the same species there. Hall had sent McCoy a proof of his illustration of *Graptolites (Didymograpsus) fruticosus* before publication, so McCoy adopted Hall's name.

Of this taxon, McCoy remarked,

> the extraordinary symmetrical grace of the regular form in which this most beautiful species is developed, renders it very easy of recognition. Even fragments are clearly marked by the great size of the broad triangular denticles.

A feature of the gerontic forms of this graptolite is the broadening curving of the distal end of the stipes, with corresponding increase of thecal size (Fig. 3).

Were graptolites hydrozoans?

McCoy thought that the thin horny rhabdosome with either uniserial or biserial thecae and polyp cells, each having an internal transverse diaphragm at the base, were features agreeing with the Hydrozoan Sertulariadae. However, the graptolites were not rooted like *Sertularia* and there is no trace of ovarian vesicles. *Corymorpha*, another hydrozoan, on the other hand, agrees with the graptolites in having a free rhabdosome.

In Ireland, McCoy's friend, Patterson of Belfast, noted that a broken stem of the hydroid zoophyte of *Tubularia*, when immersed in water, 'kept coiling itself up then uncoiling, twisting and knotting itself,' which conveyed the notion that the stem is not only flexible, but truly and entirely under the control of the zoophyte (McCoy 1846).

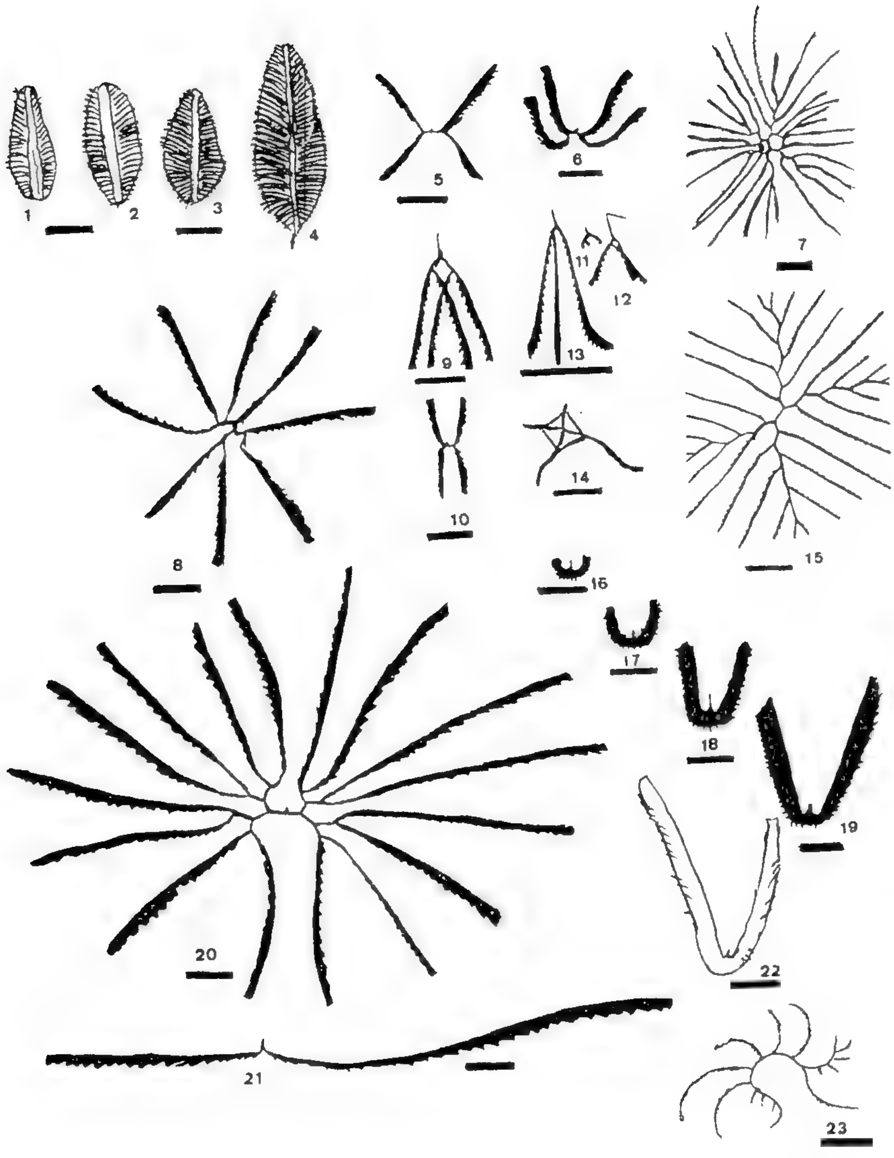

Fig. 3. Uniserial graptolites designated by McCoy mostly as the subgenus *Didymograpsus* (see Table 3). Scale Bars all represent 1 cm. 1-4, *Phyllograptus typus* showing variation in form. 5, *Tetragraptus quadribrachiatus*. 6, *Tetragraptus serra*. 7, *Goniograptus thureaui* var. *clonograptoides*. 8, *Dichograptus octobrachiatius*. 9, *Pendeograptus fruticosus* 4 Br. form. 10, *Tetragraptus approximatus* included as a zone fossil for Be-1 with *P. fruticosus* (4 Br.). 11, 12, 13, *Pendeograptus fruticosus* 3 Br. form, juvenile (11), young (12), old/mature specimens (13). 14, *Tetragraptus headi*. 15, *Goniograptus thureaui* var. *inequalis?* 16, 17, 18, 19, 22, *Isograptus caduceus* varieties: 16 var. *lunatus* (Ca-1), 17 var. *victoriae* (Ca-2), 18 var. *maximus* (Ca-3), 19 var. *maximo-divergens* (Ca-4), 22 var. *divergens* (Ca-3 - Ya-1). 20, *Loganograptus logani*. 21, *Expansograptus extensus*. 23, *Nemagraptus gracilis* (Gi-1).

The modern concept of graptolites

Debate has continued on the position of graptolites in the animal kingdom since McCoy's time. Ruedemann (1947) considered that graptolites were still allied closely to the Hydroidea, a view expressed first by Hall (1865) which no doubt influenced McCoy's views of graptolites at the time he described the Victorian graptolite fauna.

Kozlowski (1948) argued that on structural considerations graptolites were neither Coelenterates nor Bryozoans (Polyzoans). Their histology and method of budding indicates that they are most likely to be Pterobranchiata. Kozlowski (1948) has discovered a colonial form related to the living *Cephalodiscus*, the earliest Pterobranchiate.

Palmer and Rickards (1991) regard graptolites as colonial animals, like corals and most bryozoans, which they resemble. The individuals of the colony (zooids) were connected with living tissue, but the graptolite colony is usually much more geometric in its arrangement. Further, the skeletons of corals and bryozoans are largely calcareous, whilst those of graptolites are of tough, horny material called collagen. Collagen is a fibrous protein, generally preserved as black carbon, and is common today in the bones, skin and heart tissue of vertebrates.

As graptolites are extinct, the Graptoloidea ranging from Lower Ordovician to Lower Devonian, and the Dendroidea ranging from Middle Cambrian (550 Ma) to Upper Carboniferous (300 Ma), comparison with living creatures is very difficult. Today, the majority of graptolite workers regard them as hemichordates. Living hemichordates, such as *Cephalodiscus* and *Rhabdopleura,* have an external layer of soft, living tissue (known as extra-thecal tissue) connecting all the zooids. It is believed the Hemichordates linked the Invertebrates with the Vertebrates.

Observations by McCoy on some graptolite species

Lower Ordovician Uniserial Graptolites

Phyllograptus folium (Hisinger) var. *typus* (Hall)

McCoy was aware of the variation in size and form of this species. From studies of the Bohemian and Swedish species (*Didymograpsus (Phyllograptus) ovatus* (Barrande)) he predicted that they may only be varieties of *D. (P.) folium* of Hisinger. The Australian type in length and width was three or four times the size of the European varieties. The most distinctive character was the extraordinary width and thickness of the midrib or axis, which was about a quarter inch thick in the Bendigo examples. The thicker 'midrib' may be the result of two adjacent leaf-like stipes at right angles being flattened in one plane, or from one of the stipes being broken through. At least the thecae per inch or cm seemed to be constant in all species studied. McCoy remarked that this species varies from ovate to most commonly broad and semi-elliptical at the basal half, then narrowing with straighter sides towards the upper or distal end which was obtusely rounded. Other forms were the nearly regular ellipse, whilst still rarer forms had parallel sides and nearly equally rounded ends.

Hall (1865) applied the genus *Phyllograptus* to *Didymograpsus* (*Phyllograptus*) *folium* (Hisinger) from the Canadian Hudson River Formation. Hall referred an identical series of Phyllograptids which McCoy had described from Bendigo as *P. typus.* McCoy thus adopted the name *P. typus* for his large variety which was found at Lancefield, Newham, on the east bank of the Loddon, Jackson's Creek, Bullengarook and elsewhere.

Graptolites (Didymograpsus) caduceus (Salter)

McCoy described a variety of sizes of this scandent didymograptid, such as a small form and the large, broad, widely diverging forms. He believed the large forms were a distinct variety from the narrow subparallel forms, but there was a general gradation or series in size on the sample of specimens available. The common occurrence was in Castlemaine and district.

Thomas (1960) regards this species as synonymous with *Isograptus caduceus* (Salter) c.f. *I. gibberulus* and *Didymograptus gibberulus* with a list of 18 variants distinguished by later workers, especially Harris, T.S. Hall and Keble and Benson. So McCoy was correct in his observation that there were varieties in morphology and size.

Today, the recognition of the four Castlemainian sub-zones of the Victorian Lower Ordovician depend on the presence of various subspecies of *Isograptus victoriae*, as shown by Cas and VandenBerg (1988), and by VandenBerg and Cooper (1992).

Graptolites (Didymograpsus) quadribrachiatus (Hall)

Ruedemann (1947) describes *Tetragraptus quadribrachiatus* (Hall) as consisting of first order stipes of 2.6 mm with two thecae on each side. Four second order stipes spread out obliquely; straight, slender and rigid, increasing very gradually from 0.6 mm wide, to a maximum width × length of 2.4 × 42 mm. Eight to nine thecae per cm inclined at about 35-40° and about four times longer than wide. Overlap is one half to one third of their length, then outer wall slightly curved. Apertural thecal margins are straight or slightly concave, and normal to the stipe axis.

The modern taxonomy is *Tetragraptus* (Salter 1863) *quadribrachiatus* (Hall). This graptolite has proved to be long-ranging, from the Bendigonian to the Darriwilian in Victoria.

Graptolites (Didymograpsus) logani (Hall)

The rhabdosome is made up of two first order branches about 2 mm long dividing into four short second order branches about 1.4 mm long. Two repeated dichotomies in equal short intervals produced 16 fourth order stipes. However, it is possible to find one or other of third order dichotomies suppressed, or a fifth order dichotomy to give anything from 13 to 25 stipes. Stipes of the last order can be up to 18 cm long. Thecae are 8-10 per cm and three times longer than wide with an overlap of one half inclined at 30°. A large central disc may be present in the larger specimens.

Today VandenBerg and Cooper (1992) refer to this species as *Loganograptus logani logani* (Hall). The species described by McCoy was referred to as *Loganograptus logani australis* (McCoy). VandenBerg and Cooper regard McCoy's description as synonymous with *Loganograptus logani logani* (Hall) and the variation from *L. l. australis* dubious.

Graptolites (Didymograpsus) octobrachiatus Hall

The rhabdosome is made up of stipes of three orders. The first order are about 2 mm long, dichotomously branching to four second order stipes 1.5 mm long. The eight branches can be up to 10 cm long and up to 3.6 mm wide. Thecae are 8-10 per cm and about four times longer than wide. Overlap is 2/3 with a 20° inclination, curving to an outer margin of 50-55° to the stipe axis. Apertural margins are at 105-110° angle with the stipe axis. A secondary disc may be present in mature rhabdosomes. The present day taxonomy is *Dichograptus octobrachiatus* (Hall).

Graptolites (Didymograpsus) thureaui (McCoy)

This was a new genus to Hall when in 1861 McCoy sent him a proof of his plate of graptolites from the *Prodromus of the Palaeontology of Victoria* (Ruedemann 1947). *Goniograptus* was later found in Quebec rocks by Ami (1889) and from the Deep Kill by Ruedemann (1902). Thomas (1960) indicates that the species now has two variants, *Goniograptus thureaui* (McCoy) var. *clonograptoides* Harris and Thomas, and *Goniograptus thureaui* (McCoy) var. *inequalis* Harris and Thomas, which is synonymous with *G. thureaui* var. *thureaui*, both of which are Bendigonian Sub-zone 1, but the latter extending into the Be-2 Sub-zone. VandenBerg and Cooper (1992) show the range of *G. thureaui thureaui* as spanning the Bendigonian zone from Be-1 to Be-4, but restrict *G. thureaui*, var. *clonograptoides* to Be-1 only.

Graptolites (Didymograpsus) headi (Hall) Ruedemann (1947)

This is a four-stiped rhabdosome, stipes in pairs joined by a short funicle at the base and united in a broad, thickened, quadrangular, nearly square disc with a slight extension along the stipes. Thecae are ten per cm; length four times the width. Distinguished from the similar *Tetragraptus quadribrachiatus* by the size of the stipes, *T. headi* (Hall) is confined to the Castlemainian sub-zone 4 and tends to be rare in occurrence.

Upper Ordovician Biserial Graptolites

Diplograpsus mucronatus

This species is easily recognized by the little mucronate film that terminates each denticle and which extends upwards, downwards and horizontally (Fig. 4). Hall describes this species also from the Hudson River Formation not far from the British Caradoc Shale. McCoy described it from Jackson's Creek, Parish of Bulla. Thomas (1960) lists this species and synonym under *Lasiograptus (Hallograptus) mucronatus* Hall as an Eastonian graptolite in Victoria (Caradoc in Britain). VandenBerg and Cooper (1992) list two taxa, *Hallograptus hirtus* var. *mucronatus* (Hall) and *Hallograptus bimucronatus* which ranges from Eastonian sub-zones 2 to 3. They regard that it is doubtful that *D. mucronatus* occurs in Australia.

Diplograpsus pristis (Hisinger).

Occurring with *D. mucronatus*, McCoy described *D. pristis* (Hisinger) with broad triangular thecae and slightly mucronate tips. The thecae were less oblique to the axis but more strongly and broadly toothed than in *D. mucronatus*.

Thomas (1960) more recently listed this species as *Diplograpsus (Orthograptus) pristis* Hisinger. This has turned out to be an Eastonian or Caradoc form in the Upper Ordovician succession. VandenBerg and Cooper (1992) do not list it anywhere in their evaluation of the Eastonian graptolite occurrences.

Diplograpsus rectangularis McCoy

Similar to *D. pristis* is *Climacograptus rectangularis*, but it has short square thecae, set normal to the axis of the rhabdosome. The denticles of the thecae approach those of *C. bicornis*, but the base is a point and not bicornate as in that species. VandenBerg and Cooper (1992) have reassigned this form to *Pseudoclimacograptus ridellensis* (Harris) from Thomas's (1960) determination of *Climacograptus ridellensis* (Harris). McCoy reported that this form was in association with *D. mucronatus* and *D. pristis*, in what is presently known as the Eastonian zone.

Diplograpsus (Climacograptus) bicornis (Hall)

The fourth *Diplograpsus* described by McCoy in Plate 1 of the *Prodromus* was the distinctive *D. (Climacograptus) bicornis* (Hall), with the thecae 'squarely notched out of the side margins' with a characteristic bicornate base. Cas and VandenBerg (1988) show this as *Climacograptus bicornis bicornis* and as being basal Gisbornian in the Upper Ordovician. They also show another subspecies, *C. bicornis tridentatus* in the Upper Gisbornian. So with the advance of the science since McCoy's description, this graptolite has proved to be very useful in the stratigraphical mapping of the lowest division (Gisbornian) of the Upper Ordovician in Victoria. Later workers have distinguished the following variants of this species: *C. bicornis inequispinosus* Thomas; *C. bicornis longispinus* T.S. Hall; *C. bicornis peltifer* Lapworth (syn. *C. bicornis bicornis*); and *C. bicornis tridentatus* Lapworth. Thus *C. bicornis* ranges throughout the Gisbornian zone with the variants indicating particular sub-zones.

Diplograpsus palmeus (Barr).

By comparing the specimens from the parish of Bulla with those from Bohemia in the National Museum, McCoy believed this pear-shaped rhabdosome with cordiform outline which had a smooth dilatation at the distal end was an ovarian vesicle. What McCoy described later proved to be typical of the genus *Petalograptus* and this species is listed by Thomas (1960) as *Petalograptus palmeus* Hall.

Cladograpsus ramosus (Hall).

McCoy (1875) felt that the name *Cladograpsus* rather than *Dicranograptus* should apply to his specimens from the Parish of Bulla. However, in later documentation such as Thomas (1960) this graptolite is catalogued as *Dicranograptus ramosus* Hall with the variants *longicaulis* Elles and Wood, *semi-spinifer* T.S. Hall and var. *spinifer* Lapworth (syn. *semi-spinifer*) figured in Plates VII and IX of the *Prodromus*. Cas and VandenBerg (1988) figure *Dicranograptus ramosus semi-spinifer*. Thus *Dicranograptus* as the genus took precedence over *Cladograpsus*. VandenBerg and Cooper (1992) regard *Dicranograptus ramosus ramosus* Hall as equivalent to *Dicranograptus ramosus spinifer* Elles and Wood. Its range in the Gisbornian zone is Gi-1 to Gi-2.

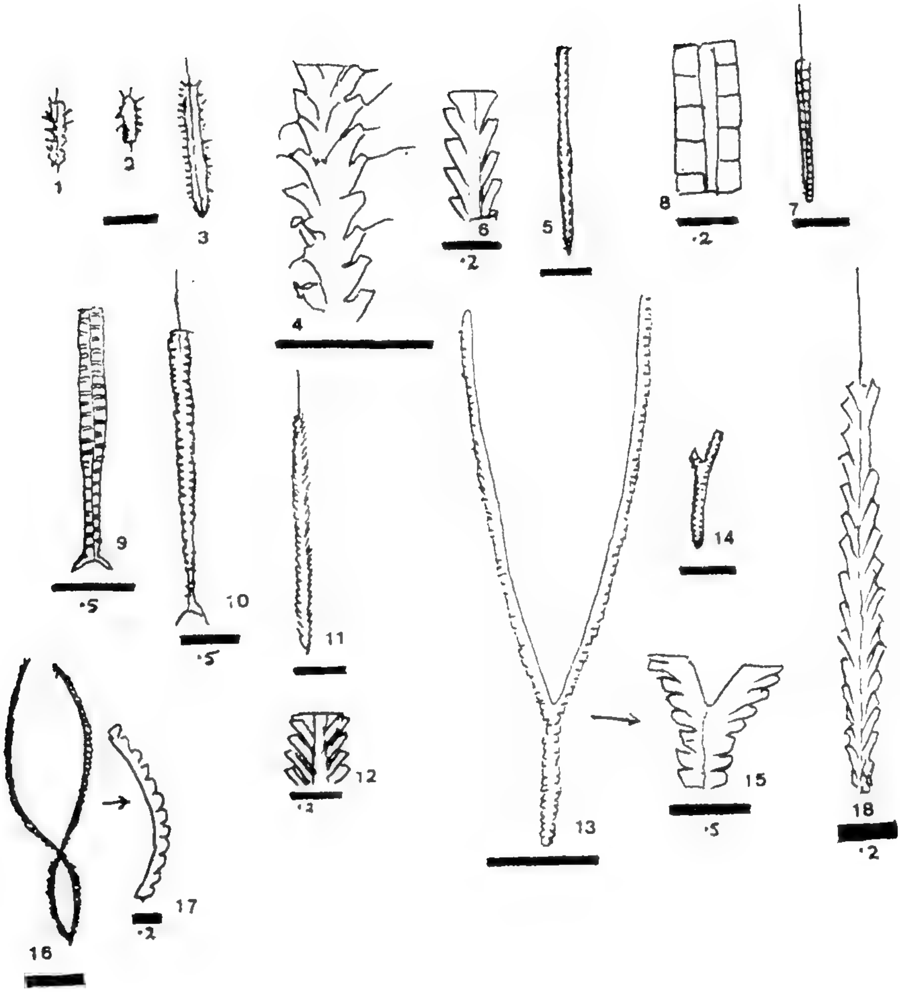

Fig. 4. Biserial graptolites designated by McCoy mostly as the subgenus *Diplograpsus* (see Table 3). Scale Bars represent 1 cm, except where indicated otherwise. 1, 2, 3, 4, *Lasiograptus (Hallograptus) mucronatus;* young (1), juvenile (2), mature specimen (3), enlargement of distal part of rhabdosome to show mucronate tips of thecae (4). 5, 6, *Diplograpsus (Orthograptus) pristis*; mature specimen (5), enlargement to show distal thecal characteristics (6). 7, 8, *Climacograptus rectangularis*, now *Pseudoclimacograptus riddellensis* Harris; mature specimen (7), distal enlargement to show rectangular thecae (8). 9, 10, *Climacograptus bicornis bicornis*; enlargement to show thecae (9), mature specimen (10). Note bicornate property of proximal end. 11, 12, *Petalograptus palmeus*; mature specimen (11), distal enlargement to show free thecae (12). 13, 14 *Dicranograptus ramosus* var. *spinifer*; enlargement to show change from biserial to uniserial thecae (15). 16, 17, *Dicranograptus furcatus*; enlargement to show uniserial stipe and thecae (17). 18 *Stomatograptus australis*, enlarged to show thecal details.

Table 2. Summary of changes in graptolite taxonomy of McCoy's 19 graptolite species.

No.	McCoy's Classification	Modern Classification	Value in Stratigraphy	Age Range in Victoria
1	*Phyllograptus folium* (His.) var. *typus* (Hall)	*Phyllograptus typus* (J. Hall)	Indicates Zone 4 with *Pendeograptus fruticosus* (3 Br)	Bendigonian Sub-zone 4 (Be-4)
2	*Diplograpsus mucronatus*	*Hallograptus hirtus* *Hallograptus bimucronatus*	Caradocian in Britain	Ea-2 - Ea-3 Eastonian Sub-zones
3	*Diplograpsus pristis*	*Diplograpsus (Orthograptus) pristis*	Caradocian in Britain	Eastonian Zone
4	*Diplograpsus rectangularis* (McCoy)	*Pseudoclimacograptus riddellinsis* (Harris)	Caradocian in Britain	Darriwilian Sub-zone 4 (Da-4) to Gisbornian Sub-zone 1(Gi-1)
5	*Diplograpsus (Climacograpsus) bicornis* Hall	*Climacograptus bicornis bicornis* (Hall)	Gisbornian, lowest Sub-zone in the Upper Ordovician succession	Gi-1 indicator with *Nemagraptus gracilis*
6	*Graptolites (Didymograpsus) fruticosus* (Hall)	*Pendeograptus fruticosus* (Hall)	2Br, 3Br & 4Br forms define the Sub-zones of the Bendigonian zone	Be-1 to Be-4 Sub-zones. Zone fossils
7	*Graptolites (Didymograpsus) quadribrachiatus* (Hall)	*Tetragraptus quadribrachiatus* (Hall)	Ranges from base of the Bendigonian to top of the Castlemainian zones	Be-1 to Be-4, Ch-1 to Ch-3, Ca-1 to Ca-4 Sub-zones. Long-ranging species
8	*Graptolites (Didymograpsus) bryonoides* (Hall)	*Tetragraptus bryonoides* (Hall) = *T. serra* Elles and Wood	Arenigian in Britain Bendigonian (Be), Chewtonian (Ch), Castlemainian (Ca), Yapeenian (Ya), Darriwilian (Da)	Be-3 to Da-3 Sub-zones. Long-ranging species
9	*Graptolites (Didymograpsus) octobrachiatus* Hall	*Dichograptus octobrachiatus* (Hall)	Bendigonian to Darriwilian zones	Long-ranging Be-1 to Da-2 Sub-zones
10	*Graptolites (Didymograpsus) logani* var. *australis* (McCoy)	*Loganograptus logani logani* (Hall)	*L. logani* Be-1 to Da-3	*L. logani logani* to Ca-3 Zone
11	*Graptolites (Didymograpsus) extensus* (Hall)	*Expansograptus extensus*	Lower Arenigian from Upper Tremadocian in Britain Lancefieldian, Bendigonian to Chewtonian in Victoria	La-3 to Ch-2 Sub-zones
12	*Graptolites (Didymograpsus) caduceus* (Salter)	*Isograptus victoriae lunatus*, *I. victoriae victoriae*, *I. victoriae maximus*, *I. victoriae maximo-divergens* *I. victoriae divergens* Harris	All variants used to Sub-zone the Castlemainian Zone. *I. v. divergens* indicates Ya-1	Ca-1 to Ca-4 on *I. v. l.* (Ca-1), *I. v. v.* (Ca-2), *I. v. m.* (Ca-3), *I. v. m.d* (Ca-4)
13	*Diplograpsus palmeus* (Barrande)	*Petalograptus palmeus* Hall	Lower Llandovery in Wales	Keilorian (Llandovery) (Lower Silurian)
14	*Cladograpsus* (Geinitz) *ramosus* (Hall)	*Dicranograptus ramosus ramosus* (Hall) – *D. ramosus spinifer* Elles and Wood	Gisbornian Zone, Upper Ordovician	Gi-1 to Gi-2 Sub-zones
15	*Cladograpsus* (Geinitz) *furcatus* (Hall)	*Dicranograptus furcatus* (Hall) = *D. kirki*, – *D. f. minimus* (Lapworth)	Gisbornian Zone	Rare in Gisbornian Zone. Is doubtful
16	*Graptolites (Didymograpsus) gracilis* Hall	*Nemograptus gracilis* (Hall)	Marks the base of the Upper Ordovician in Victoria	Gi-1 Sub-zone with *Climacograptus bicornis bicornis*
17	*Retiolites australis* (McCoy)	*Stomatograptus australis* (McCoy)	Late Llandoverian	Springfield Formation in Central Victoria
18	*Graptolites (Didymograpsus) thureaui* (McCoy)	*Goniograptus thureaui thureaui* (McCoy) *Goniograptus thureaui clonograptoides* (Harris and Thomas)	Lower Bendigonian Zone Lower Bendigonian Zone	Be-1 to Be-4 Sub-zones Be-1 indicator
19	*Graptolites (Didymograpsus) headi* Hall	*Tetragraptus headi* (Hall)	Upper Castlemainian Zone	Ca-4 indicator but rare

Cladograpsus furcatus Hall

This species, described by McCoy (1875) as rare in the parish of Bulla, is documented by Thomas (1960) as *Dicranograptus furcatus* Hall. Later workers have shown this form to range from Gisbornian to mid-Eastonian. VandenBerg and Cooper (1992) state that numerous Australian records have listed this species, but there are no descriptions, which makes its presence uncertain.

Dicranograptus furcatus minimus Lapworth is equal to *Dicranograptus kirki*, so the presence of *D. furcatus* in Australasia is doubtful.

Graptolites (Didymograpsus) gracilis Hall

McCoy remarked on the smallness and inconspicuous nature of the thecae, which looked like root hairs instead of stipes, and that only the common canal running along the back of the thecae could be seen. However, there was a slight roughness indicating the presence of thecae as in New York specimens. He likened the specimens to *Rastrites*, except that the thecae were not tubular. McCoy was doubtful about this specimen being assigned to *Didymograpsus*, remarking that the unusual growth form could warrant another subgenus for its classification.

McCoy's suspicion was well founded as Thomas (1960) gives *Nemagraptus gracilis* as a separate genus and species. Cas and VandenBerg (1988) demonstrate that this graptolite is the zone fossil for the base of the Gisbornian (Gi-1) and with *Climacograptus bicornis* confirms the stratigraphical mapping of this zone.

This species marks the base of the Upper Ordovician succession in Victoria, and is also the zone fossil for the base of the Gisbornian Zone Gi-1.

Silurian Biserial Graptolites

Retiolites australis (McCoy)

McCoy reports that this specimen was found in a mudstone of Wenlock age in the United Kingdom. The Victorian occurrence is to the north-west of Keilor. *Retiolites* occurs at the base of the Upper Silurian in Bohemia. *Retiolites geinitzianus* (Barrande) was reported by VandenBerg (1988) to be associated with this species. It is listed by him in the Springfield Formation and indicates a Late Llandovery age. *R. australis* is very much smaller with nearly double the number of thecae per cm. Today *R. australis* is regarded as Late Llandovery in age.

Thomas (1960) indicates that *Retiolites australis* (McCoy) is a synonym of *Stomato-graptus australis* (McCoy).

Stratigraphic value in Victoria

Table 2 shows how the taxonomy of the 19 graptolite species, which McCoy described in the *Prodromous*, has evolved to the present day. It also shows the value of these species in Victorian stratigraphy.

Four of these species are rare and seem to have been lost in the evolving literature, viz *Dicranograptus furcatus*, *Tetragraptus headi*, *Climacograptus rectangularis (C. riddellensis harris)* and *Petalograptus palmeus*. Of the remainder, long-ranging species are four in number - *Tetragraptus quadribrachiatus*, *T. bryonoides*, *Dichograptus octobrachiatus* and *Expansograptus extensus*. This leaves eleven species which are restricted to subzones or are actual zone fossils (Table 3).

Table 3. Stratigraphic value of graptolites in McCoy's *Prodromus*.

Species	Sub-zone/Zone
Pendeograptus fruticosus (4 Br.) and *Tetragraptus approximatus*	Be 1
Pendeograptus fruticosus (4 Br. alone)	Be 2
Pendeograptus fruticosus (3 and 4 Br.)	Be 3
Pendeograptus fruticosus (3 Br. alone)	Be 4
Phyllograptus typus	Be 4
Isograptus victoriae var. *lunatus*	Ca 1
Isograptus victoriae var. *victoriae*	Ca 2
Isograptus victoriae var. *maximus*	Ca 3
Isograptus victoriae var. *maximo-divergens*	Ca 4
Climacograptus bicornis with *Nemagraptus gracilis*	Gi 1
Diplograpsus (Orthograptus) pristis and *Lasiograptus (Hallograptus) mucronatus*	Eastonian Zone
Stomatograptus australis and *Petalograptus palmeus*	Early Silurian (Keilorian)

Thus McCoy brought to the attention of graptolithologists eleven of the 19 species which needed further investigation for possible significance in Ordovician and Early Silurian stratigraphical mapping, not only in Victoria but world-wide.

Conclusion

The Australian Ordovician has now been divided into Upper and Lower divisions. The boundary between the two is at the base of the *Nemagraptus gracilis* zone of Cas and VandenBerg (1988).

Previously Harris and Thomas (1938) had proposed a three-part division with the Middle Ordovician (formerly the Darriwilian) between the Yapeenian Zone and the Gisbornian Zone. However, Cas and VandenBerg argue that this Middle Ordovician differs in concept from any other region. Furthermore, it represents only a relatively short time interval (VandenBerg and Cooper 1992). The present subdivision of the Ordovician in Victoria is consistent with the 1986 resolution, where the Cambrian-Ordovician boundary is below the *Dictyonema flabelliforme* band at Lancefield and the Ordovician-Silurian boundary is with the first appearance of *Parakidograptus acuminatus* at Darraweit Guim.

Such mapping detail has been the outcome of later workers capitalizing on McCoy's first descriptions of the 19 graptolite species discussed in this paper. As a result of this work, Victorian Ordovician graptolite sequences have been shown to be as complete as any in the world.

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'THE LATE PROFESSOR SIR F. M'COY, F.R.S., &C. - An appreciative memoir of the late professor appears in the *Geological Magazine* for June, 1899. After giving the general details of his life, an outline of which has already been published in these pages, a list is given of his smaller contributions to natural science. These number sixty-nine, extending from 1838 to 1876, with a final communication in 1881. They cover a vast range of subjects, and the greater number were published in the *Annals of Natural History Magazine*.'

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McCoy's Mammals

John Seebeck[1] and Robert M. Warneke[2]

Introduction

Although Frederick McCoy was principally a geologist and palaeontologist (Pescott 1954; Darrragh 1992), he was a true generalist, interested in and knowledgeable about a wide range of both invertebrate and vertebrate fauna, modern and fossil. As Professor of Natural Science at The University of Melbourne and Director of the embryonic National Museum of Victoria (now Museum Victoria) he recognised the necessity for such institutions to be able to demonstrate the diversity of lifeforms to the community and was therefore at great pains to develop both teaching and exhibition collections. For whatever reasons – lack of time, lack of collecting opportunities or perhaps because the field had been so well covered by his contemporary and friend John Gould (whose singular publication *The Mammals of Australia* (Gould 1845-1863) was completed during McCoy's time as Professor) McCoy did not specifically pursue the study of the contemporary mammals of Victoria. In an essay on the natural history of Victoria, written to accompany the catalogue of the 1861 Victorian Exhibition, McCoy observed that 'the Recent mammalia … are so fully known from the admirable works [of Gould] that I shall not allude at all to them …' (McCoy 1861: 170). However, when the opportunity arose for him to investigate something new, he did so with appropriate professional skill, and he investigated and described a number of mammal species, both contemporary and fossil. In this contribution we will examine these in their several categories.

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Descriptions of new, contemporary mammals

McCoy described and named two modern terrestrial mammal species, *Halmaturus wilcoxi* in 1866 (McCoy 1866), and *Gymnobelideus leadbeateri* in 1867 (McCoy 1867a). *Halmaturus wilcoxi* was described from two specimens collected by J.F. Wilcox at Richmond River, New South Wales. Iredale and Troughton (1934) placed the species in *Thylogale stigmatica*, subspecies *wilcoxi* Red-legged Pademelon. Dixon (1970) confirmed this nomenclature and noted that the type specimens, a female and a male, are held by Museum Victoria. According to Strahan (1995) the subspecies still stands.

Gymnobelideus leadbeateri Leadbeater's Possum was described from two specimens collected from the Bass River, and named after the skilled taxidermist at the National Museum, John Leadbeater. The original description, in the *Annals and Magazine of Natural History*, was illustrated with an uncoloured lithograph of a mounted specimen, fore- and hind-feet and teeth. The drawing was relatively crude and simplistic, but clearly recognisable (Fig. 1). The description, accompanied by a redrawn, coloured plate showing the animal, fore- and hind-feet and the skull and teeth, was re-published as Plate 91, in Decade X of the *Prodromus of the Zoology of Victoria* (McCoy 1878-1885). The genus and species still stand and Leadbeater's Possum is now one of Victoria's two State faunal emblems (the other being the Helmeted Honeyeater).

A third species of modern mammal was described in 1867, *Physalus grayi*, a 'new species of the genus *Physalus*, or "Finner"', from a specimen that washed up on the coast at Jan Juc in August 1866 (McCoy 1867b). Although this 'species' was subsequently synonymised within *Balaenoptera physalus* Fin Whale by Iredale and Troughton (1934), their deter-

Fig. 1. First illustration of Leadbeater's Possum *Gymnobelideus leadbeateri* McCoy. Lithograph by J. Basire. Published in *Annals and Magazine of Natural History, Series 3,* 1867, **20,** Plate 5, 287-88.

mination was in error, and Brazenor (1950) and later Wakefield (1967) recognised that the specimen was in fact *Balaenoptera musculus*, the Blue Whale. The full skeleton was articulated and displayed at The University of Melbourne until 1899, when it was apparently dismantled and disposed of rather than being reconstructed at the new Museum. A photograph of the skeleton, incorrectly captioned Black Right-Whale (Southern Right Whale, *Eubalaena australis*) is opposite p. 66 in Pescott (1954). All that remains are the right tympanic bulla and four baleen plates (Dixon and Frigo 1994).

Comments on, and descriptions of, contemporary mammals

McCoy was concerned with ensuring that the National Museum established its role as one of the essential cultural institutions of the increasingly sophisticated society that Melbourne was becoming. One way to demonstrate its value was by publishing scholarly and readily accessible accounts of the natural history of the colony, as had been already done for the geology and palaeontology. The publication of the *Prodromus of the Zoology of Victoria* (McCoy 1878-1885) was to be the precursor to a more detailed and comprehensive documentation of the natural history of Victoria. The *Prodromus* included descriptions and figures of three contemporary mammal species apart from *Gymnobelideus* – all are marine mammals, and one of them was featured twice. The species were the Sea Leopard (Leopard Seal), *Stenorhynchus* (= *Hydrurga*) *leptonyx* Plate 21, Decade III; Yellow-sided (= Common) Dolphin, *Delphinus novae zealandiae* (= *delphis*) Plate 22, Decade III; and Australian Sea-bear or Fur-seal (Australian Fur-seal), *Euotaria cinerea* (= *Arctocephalus pusillus*) Plate 31, Decade IV and Plate 71, Decade VIII.

Leopard Seals are not infrequent visitors to the Victorian coastline. The specimen illustrated was drawn from life by Ludwig Becker, the artist who died on the Burke and Wills expedition, and it became one of several specimens in the Museum collection. Interestingly, Gould himself figured this species, one of only two marine mammals that he included in *The Mammals of Australia* (the other being the Australian Sea Lion, *Neophoca cinerea*). Despite their vernacular name, Common Dolphins are not now at all common in Port Phillip Bay. The most abundant dolphin in the bay is the Bottlenose Dolphin *Tursiops truncatus*

McCoy (1878-1885: 10) noted that sailors called the dolphin the 'Bottle-nose'. The Australian Fur-seal rookery at Seal Rocks was visited by McCoy, where he collected an adult male and female, and a young one. The account accompanying Plate 71 provides a very detailed picture of the colony that today remains a major stronghold for the species.

In his 1861 essay, McCoy offered comment about the mainland existence of the Spot-tailed Quoll *Dasyurus maculatus*, which had hitherto been understood to be restricted to Tasmania. Several specimens had reached the Museum from the forests close to Melbourne. He also announced his recognition that the Dingo was indigenous, an issue that had been in debate at the time (McCoy 1861). In addition, he discussed the mammal fossil record in Victoria – but more of that later.

Five years later, Victoria hosted the Intercolonial Exhibition, and McCoy wrote another essay, titled *On the Recent Zoology and Palaeontology of Victoria*. By way of introduction, he explained that he would only refer 'to those species of animals affording economically useful materials, or of some special present interest in relation to unsettled scientific questions' (McCoy 1867b: 309); thus his comments did not set out to include observations on all the mammals known for the State. Indeed, he began by stating that 'very few of the Victorian quadrupeds are economically useful', and most of the notes were concerned with the value of the skin (as leather or fur) or the animal as food. It was an important part of colonial life to make use of the available natural resources, and McCoy may well have seen it as part of his educational role to give such advice as he could to the man in the street – and, hopefully, to the man in the bush as well. Marine mammals such as stranded large whales could and did provide oil and whalebone, both of which were extracted and sold.

Despite this somewhat narrow consideration of the State's mammal fauna, McCoy

Table 1. Mammals listed in McCoy's essay for the Intercolonial Exhibition, 1866-67.

Species, as reported in McCoy	McCoy's vernacular names	Present scientific name	Present vernacular
Dasyurus viverrinus	Native Cat	*Dasyurus viverrinus*	Eastern Quoll
Perameles obesula	Bandicoot	*Isoodon obesulus*	Southern Brown Bandicoot
Perameles fasciata	Bandicoot	*Perameles gunnii*	Eastern Barred Bandicoot
Phascolomys	Wombat	*Vombatus ursinus*	Common Wombat
Phalangista vulpina	Opossum	*Trichosurus vulpecula*	Common Brushtail Possum
Phalangista Viverrina var Victoriae	Ring-tail Opossum	*Pseudocheirus peregrinus*	Common Ringtail Possum
Hypsiprymnus	Kangaroo Rat	*Potorous tridactylus*	Long-nosed Potoroo
Lagorchestes	Hare-Kangaroo	*Lagorchestes leporides*	Eastern Hare-wallaby
Macropus fuliginosus	Sooty Kangaroo	*Macropus fuliginosus*	Western Grey Kangaroo
Macropus major	Old Man, Boomer Kangaroo	*Macropus giganteus*	Eastern Grey Kangaroo
Macropus ocydromus		*Macropus fuliginosus*	Western Grey Kangaroo
Halmaturus bennetti		*Macropus rufogriseus*	Red-necked Wallaby
Osphranter rufus	Red Kangaroo	*Macropus rufus*	Red Kangaroo
Halmaturus Brachyurus		*Thylogale billardierii*	Tasmanian Pademelon
Halmaturus uallabatus	Wallabi	*Wallabia bicolor*	Black Wallaby
Molossus australis		*Tadarida australis*	White-striped Freetail Bat
	Native Dog or Dingo	*Canis lupus dingo*	Dingo
*Arctocephalus lobatus**	Eared Seal	*Arctocephalus pusillus*	Australian Fur-seal
Stenorhynchus leptonyx	Sea Leopard	*Hydrurga leptonyx*	Leopard Seal
Physalus Grayi	Finner	*Balaenoptera musculus*	Blue Whale

* In the later *Prodromus of Zoology* (1878-1885), McCoy referred to this species as *Euotaria cinerea*, a combination apparently derived from J.E.Gray's 1866a, 1866b and 1871 reviews of fur seal and sea lion taxonomy. However, as Gray (1866b, 1871) erected *Euotaria* as a sub-genus of *Arctocephalus* including [South] American species, and *Gypsophoca* for Australian species, McCoy seems to have erred.

did list some of the species found in Victoria. It is a pity that he did not choose to provide a list of all the mammals known, as he did for the birds. Table 1 lists the species reported. Of interest are comments about the biogeography of the large kangaroos. McCoy believed that there were four species present and commented on the differences in appearance and distribution. Two species that he reported are now recognised to be conspecific – *Macropus fuliginosus* and *M. ocydromus* but the taxonomy of the grey kangaroos was not sorted out until the 1970s (Kirsch and Poole 1972). McCoy was not just a narrowly focussed academic. He was very much alert to the ecological consequences of fencing pastoral land, which had resulted in a large increase in numbers of kangaroos, often necessitating the killing of 'hundreds ... on the squatters runs merely to save the grass for the sheep' (McCoy 1867b: 309). The increase in kangaroo numbers was also attributed to the extensive poisoning of Dingoes. Somewhat surprisingly, McCoy made errors of identification of the wallabies found in Victoria and Bass Strait, believing that the Black Wallaby (now *Wallabia bicolor*) was present on Bass Strait islands as well as in southern Victoria, and attributing the name of the Quokka *Setonyx brachyurus* of Western Australia to the Tasmanian Pademelon *Thylogale billardierii* which, in his time, was still present in coastal eastern Victoria. McCoy's confusion was possibly a reflection of the very limited reference material available to him in Australia and his unavoidable reliance on taxonomic reviews published in Europe, where most of the significant collections of birds and mammals were held. Many years were to pass before adequate geographically representative reference material was available in Australia for such comparative zoology.

Furs from possums and 'native cats' (*Dasyurus viverrinus*, Eastern Quoll and possibly also Spot-tailed Quoll) were also seen as desirable products, and McCoy urged the promotion of them into the

Table 2. Fossil mammals named by McCoy, with their present-day taxonomic standing. Date: Date of description.

Species, as named by McCoy	Date	Modern status of nomenclature	Authority
Dasyurus affinis	1865	*Dasyurus maculatus*	Mahoney 1964
Thylacoleo oweni	1876	*Thylacoleo carnifex*	Archer and Dawson 1982
Phascolomys pliocenus	1866	*Vombatus ursinus*	Wilkinson 1978
Diprotodon annextans	1861	Uncertain - possibly *D. australis*	Archer *et al.* 1984
Diprotodon longiceps	1865	Uncertain – was to replace *annextans*, and therefore possibly *D. australis*	Archer *et al.* 1984
Bettongia cuniculoides	1868	Uncertain - but most probably *B. gaimardi*, given the locality (Loddon River)	This paper; Archer *et al.* 1984 considered that the 'distinction of this taxon is unclear'
Hypsiprymnus trisulcatus	1865	*Potorous tridactylus*	Mahoney 1964
Arctocephalus williamsi	1866	*Neophoca cinerea*	Fordyce and Flannery 1983
Cetotolites baileyi	1879	*Nomen nudum**	Fordyce 1984
Cetotolites leggei	1879	*Nomen nudum*	Fordyce 1984
Cetotolites pricei	1879	*Nomen dubium***	Fordyce 1984
Cetotolites nelsoni	1879	*Nomen dubium*	Fordyce 1984
Cetotolites nelsoni var *rugosa*	1879	Ditto	Fordyce 1984
Parasqualodon wilkinsoni	1866	Possibly conspecific with *Prosqualodon davidis*	Fordyce 1984
Ziphius (Dolichodon) geelongensis	1882	*Nomen dubium*	Fordyce 1984
Physetodon baileyi	1879	Genus and species still stand, but possibly *nomen dubum*	Fordyce 1984

* *Nomen nudum*: A name that fails to conform to certain Articles in the International Code of Zoological Nomenclature (1985). It is not an available name and therefore the same name may be made available later, from which time the authority would date.
** *Nomen dubium*: A name of unknown or doubtful application.

European fur trade. 'So abundant and easily obtained are these skins ...' (McCoy 1867b: 309). Would that it were still so! The fur from the Fur Seal was reckoned to be 'of good quality when properly dressed' (McCoy 1867b: 309). However, these seals had been heavily exploited for many decades prior to McCoy's comments, and while there remained a sporadic and low-level trade in seal skins, the industry had effectively finished many years prior, so that despite the quality of the skins, there was not much profit to be made from the species by McCoy's time.

Descriptions of mammal fossils

McCoy's palaeontogical expertise was at the forefront in most of his mammalian investigations. Between 1861 and 1882 he described 16 taxa of fossil mammals (Archer *et al.* 1984; McCoy 1874-1882; Table 2). Nine of these descriptions appeared in the *Prodromus of Palaeontology*, 1874-1882.

He described *Diprotodon annextans* in 1861 and *D. longiceps* in 1865 (Archer *et al.* 1984 considered that this was a replacement name for *D. annextans*). He examined a collection of fossil bones found by A.R.C. Selwyn in a cave at Gisborne during the early 1860s, commenting on the species present in his 1861 essay. In a note that was present on some printings of a Geological Survey of Victoria map (GSV Quarter Sheet 7 NW, 1865), McCoy (1865) listed the following species of mammals as being present (we have reproduced the names as given): *Canis Dingo*; new Genus of Carnivorous animal; *Diabolus (Sarcophilus) Ursinus*; *Dasyurus viverrinus*; *Dasyurus affinis*; *Phalangista vulpina*; *Phalangista* New Species; *Perameles obesula*; *Hypsiprymnus trisulcatus*; *Macropus* nearly allied to *M. ualabatus*. He thus described two new species of marsupial – *Dasyurus affinis*, a 'new species nearly as large as *D. maculatus* but differing in proportions', and *Hypsi-*

prymnus trisulcatus, a new species a little smaller than the living *H. minor* and having only 3 sulci [grooves] on the large premolar in the lower jaw.

Mahoney (1964) reviewed the identities of the two new species and concluded that *Dasyurus affinis* was in fact *D. maculatus*, measurements and morphology of the syntypes falling within the normal range of that species. Gill (1953b) figured the syntypes, which appear to be typical *D. maculatus*. *Hypsiprymnus trisulcatus* was, similarly, relegated to a junior synonym of *Potorous tridactylus* by Mahoney, who pointed out that variation in the number of sulci was apparent within that species and thus was not a discriminating character. Mahoney considered that the fauna described in McCoy's note was representative of the modern fauna of the area. That is true, with the exception of *Sarcophilus*. Several records of that species in cave deposits in Victoria have been reported (Mahoney 1912; Gill 1953a, c) and it is likely that it was present on the mainland until fairly recently (in geological terms).

Mahoney (1964) was unable to identify McCoy's 'new Species of Carnivorous animal', noting that one possibility was *Hydromys chrysogaster* Water Rat. McCoy himself (1861) mentioned that *Hydromys* was present in the 'Mount Macedon caverns' (= Gisborne) deposits, but made no further reference to the species. *Hydromys* seems unlikely. Mahoney quotes Selwyn's description, which likens the skull to that of 'a domestic cat, but not more than half the size': perhaps a kitten? The conundrum will remain unless the specimen is found.

McCoy was enthusiastic about fossil marine mammals and described nine species - one otariid seal, the remainder cetaceans. Fordyce (1984, 1991) has assessed these species and concluded that most are invalid. Further review may reveal that those names still standing are indeed synonyms.

It is a somewhat sad reflection of McCoy's diligent and knowledgeable descriptive zoology, then, that only one species of mammal, modern or fossil, has truly stood the test of time and review. It is, however, a pleasing legacy that that species should be Leadbeater's Possum, Victoria's only endemic mammal and one of its State Faunal Emblems.

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We wish to thank Tom Darragh, Museum Victoria, for helpful discussions about Frederick McCoy and for the provision of copies of difficult-to-obtain references, and Carol Harris, Arthur Rylah Institute Librarian, for facilitating copies of other essential references. The State Library of Victoria provided a copy of McCoy's illustration of Leadbeater's Possum, which forms Fig. 1.

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Comments on the Ostracod Genus *Bairdia* M'Coy, 1844

Mark Thomas Warne[1]

Concerning the initial description of the crustacean/ostracod genus *Bairdia* M'Coy, 1844 from the Carboniferous of Ireland, Malz (1988) commented that 'McCoy was not aware of the importance of his discovery then, for as often happens great discoveries are evaluated much later.' Malz (1988) also mused that it was not until a lifespan later that the full importance of M'Coy's description of *Bairdia* became apparent (with the erection of the family Bairdiidae Sars 1888).

Interestingly, the original lateral view diagram in M'Coy, 1844 of *Bairdia curtus* (type species for genus) illustrates this species in an upside down fashion with respect to its probable original orientation in life (Fig. 1A).

Fossil specimens attributed to *Bairdia* range back in geological time to the Ordovician, with species of this genus becoming common in open shallow marine palaeoenvironments from the mid Palaeozoic (Fig. 1B). For many years the *Bairdia* generic concept was applied to younger post-Palaeozoic fossil and living ostracods with similar morphology – and some taxonomists still utilise this generic name for modern species. However, Cainozoic specimens of *Bairdia s.l.* have been split into a number of different genera by Maddocks (1966). In particular, the genera *Neonesidea* Maddocks, 1966 and *Paranesidea* Maddocks, 1966 (Fig. 1C) most closely resemble *Bairdia* so much so that it may be argued that using the carapace as morphological grounds for distinguishing the former two from the latter are still questionable. This is largely a consequence of one of the most salient features of *Bairdia s.l.* ostracods – their subtrapezoid shaped carapace – which has

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remained a very dominant and conservative morphological feature throughout the evolutionary history of the Bairdiidae.

Bairdia s.l. group ostracods have been abundant and ubiquitous faunal elements of shallow marine realms throughout most of the Phanerozic with a few species becoming adapted to deep ocean environments from about the mid Cretaceous. They account for a significant component of modern day ostracod biodiversity. Indeed, so common are *Bairdia s.l.* ostracods in fossil and modern marine faunas that they can be considered as one of the most widespread and long ranging of all advanced life forms to have inhabited the earth.

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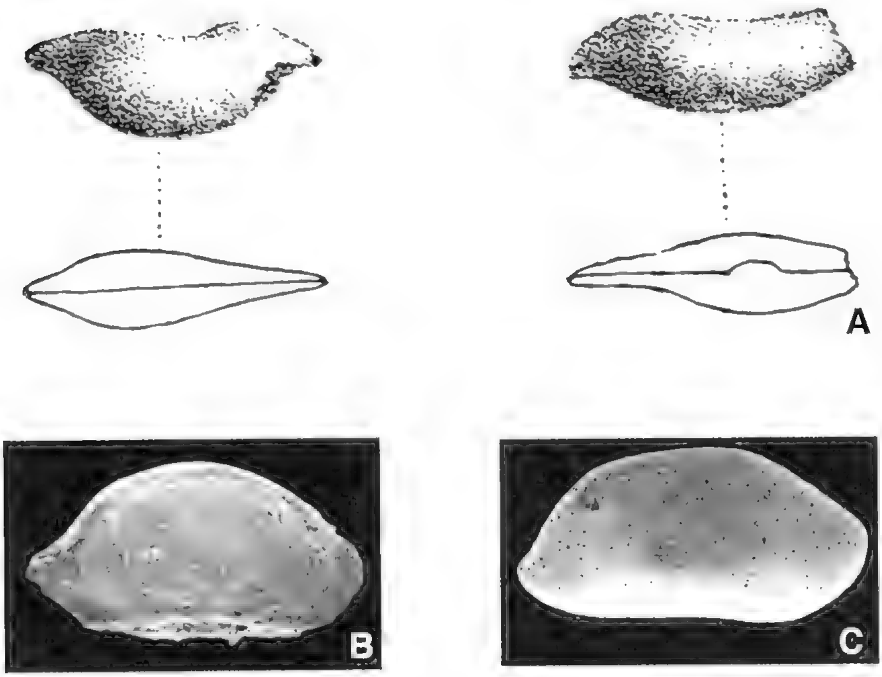

Fig. 1. A. Enlargement (×2.5) of illustrations of *Bairdia curtus* M'Coy, 1844 (Plate 23, fig. 6) and *Bairdia gracilis* M'Coy, 1844 (Plate 23, fig. 7). M'Coy recorded the length of *B. curtus* as being equal to 'one line'. M'Coy recorded the length of *B. gracilis* as being equal to 'half a line'. B. *Bairdia* sp. Carapace from Lower Devonian Buchan Caves Limestone outcropping near Lilly Pilly Cave, Buchan, eastern Victoria. Length of specimen is 0.60 mm. C. *Paranesidea* sp. Right valve from latest Upper Miocene Black Rock Sandstone intersected in Nepean 1 borehole at 178.3 metres depth (Nepean Peninsula, southern Victoria). Length of specimen is 0.65 mm.

A 'Bite' From the Past

Leigh Ahern[1]

During spring of 1999 I was fortunate to have the opportunity of assisting Mr A. J. (John) Coventry, the Officer-in-Charge of Herpetology at the Museum of Victoria, in carrying out re-labelling and other curatorial work on parts of the State herpetological collection, then housed at Abbotsford, near Melbourne. The task frequently involved checking to ensure that specimen naming was in accord (as far as practicable) with current taxonomy and that former references to the specimen (often as different taxa) in literature or historic museum registers were recorded on the museum's modern computerised database.

The work provided me with the opportunity to glimpse many preserved herpetological specimens dating back over the last 150 years or so. I was especially impressed by the number of fine snake specimens, many large and difficult to handle when alive, and often highly venomous, yet collected from some extremely remote parts of Australia. It was indeed a thrill to examine specimens still displaying the hand-written field labels of eminent naturalists of the past, including Gerard Krefft, Donald Thomson, Peter Rawlinson, and many others, and to view their additional contributions in the form of register entries and unpublished museum reports and notes.

An added benefit of working with John was the opportunity to marvel at the depth of knowledge gained during a career very purposefully dedicated to expanding and improving this State's herpetological collection. Under John's guidance, I often spent the lunch-hour perusing many of the Museum's literary gems on herpetology and wider natural history subjects. It was he who directed me to one of its most interesting holdings, the *Prodromus of the Zoology of Victoria* by Professor Frederick McCoy, published in successive parts between 1878 and 1890.

On one occasion I came upon an uncharacteristically damaged spirit-specimen—a snake labelled as *Diemenia superciliosa* (now known as the Western Brown Snake *Pseudonaja nuchalis*) -which had been donated by a 'Mr Strickland'. The unfortunate reptile appeared to have been all but chopped through in some four or five separate places along the body. The jar label referred to this specimen as having been 'figured' in Professor McCoy's *Prodromus*. Curious to understand what interest Professor McCoy might have had in such a poor specimen, I looked up the relevant Plate (23) in Volume I of the *Prodromus* (Fig. 1). The specimen had in fact only been used as one of a series of seven snakes from which morphological measurements had been tabulated for the species, and an 'average specimen' depicted.

Reading on, however, I discovered that Mr Strickland's specimen had a chilling relevance to the remarks made by Professor McCoy regarding contemporary treatments for the bite of this highly dangerous species. He wrote: 'In the experiments made by Dr Halford on snake-poisoning, tabulated in the *Medical Society's Journal* for March 1875, all the cases of people bitten by the Brown Snake and treated by the injection of ammonia recovered; but in one of the last cases mentioned in the public journals (*Bendigo Advertiser*, 27 October 1877), a snake of this species, 3 feet 6 inches long (the fifth in the above table of measurements), bit Mrs. Eleanor Ingleby, residing at Sebastian, in the hand, and she died from the effects within fifty minutes. The acting coroner, Mr. Strickland, who held the inquest, sent the specimen to the Museum, where it is now deposited, so that the species is determined with certainty.'

This incident, while illustrating what may have been a frequent tragedy in early colonial days, also highlights a seldom recognised feature of Victoria's natural history collections -namely, the stories associated with the collection itself. A surprising amount of fascinating historic detail was revealed to me even in the simple process of reviewing and rearranging the existing herpetological collection. Sadly, with every passing day, more of this rich historic detail

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recedes forever into dusty oblivion created by modern times and changing administrative priorities. Thankfully, Professor McCoy's *Prodromus* remains one means by which we can still experience at least a little of the former magic and adventure of Victoria's early inquiries into natural history.

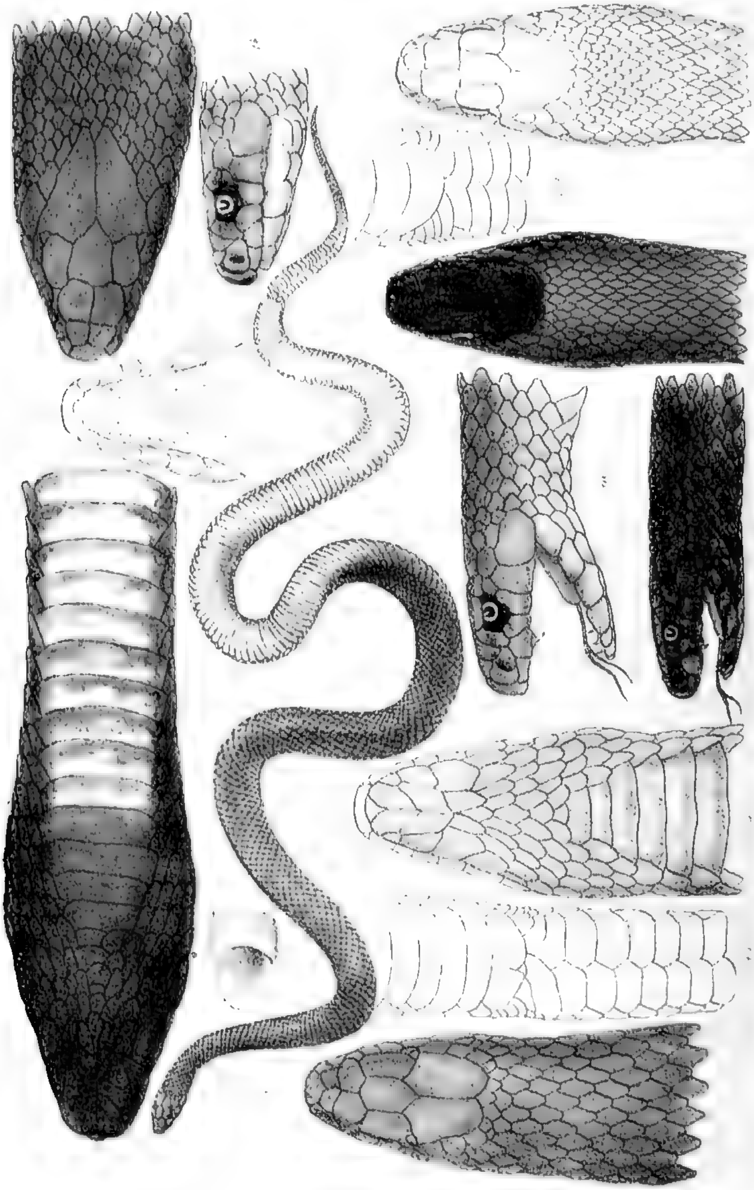

Fig. 1. The Common Brown Snake *Diemenia superciliosa* (fig. 1); Small-scaled Brown Snake *Diemenia microlepiodota* (McCoy) (figs. 2 & 3); The Shield-fronted Brown Snake *Diemenia aspidorhyncha* (McCoy). *Prodromus of the Zoology of Victoria*, Volume I, Decade III. Plate 23. Lithograph by A. Bartholomew and F. Schonfeld under the direction of Professor McCoy.

Frederick McCoy – the Challenge of Interpretation of Thylacoleonid Fossil Material

Bernard Mace[1]

Abstract

To 19th century biologists, Australia was a 'living museum' of marsupial species, and it became apparent that many of the extant genera were represented by fossils in the Tertiary geological strata of the northern hemisphere. Large marsupial carnivores were surprisingly absent from the extant fauna, except in Tasmania, and it was the palaeontologists, initially overseas experts exemplified by Professor (Sir) Richard Owen, who discovered that the Late Pleistocene was well served with marsupial carnivores. The most spectacular of all, and among the last to be verified, was *Thylacoleo carnifex* (Owen), the Marsupial Lion. The characterisation of this unique animal as a carnivore, rather than herbivore, omnivore or scavenger, was the subject of prolonged argument among experts of the time. Frederick McCoy was one of an emerging group of local scientists to enter the debate, and made an outstanding contribution. (*The Victorian Naturalist* **118** (6), 2001, 287-293.)

The apparent absence of large marsupial carnivores on mainland Australia has presented a puzzle to modern-day zoologists, but to 19th century palaeontologists the picture of extinct fauna was very different. Following the earliest days of biological discovery when the observations of Darwin, Banks and Baudin were building the foundations of scientific knowledge of the unique biology of this country, the layers of biological history and evolution were likewise beginning to be revealed by eminent palaeontologists of the time. Professor Richard Owen, Georges Cuvier, T.H. Huxley, Lydekker, Gervais and Clift were prominent overseas experts who analysed fossil material sent to Europe from Australia. Subsequently, an emerging body of Australian scientists, including Gerard Krefft, Professor Frederick McCoy, Professor J.W. Gregory, Henry Brown and Charles De Vis, contributed their interpretations to the growing body of overseas expertise, as the exploratory and geological expeditions yielded fossil records of an extraordinary prehistory (Rich *et al.* 1985)

It became apparent that the extinct marsupial fauna was characterised not only by a remarkable profusion and diversity of species, but also by the expected balance of carnivores and herbivores, at least well into the late Pleistocene. In this geologically recent period, the large physical proportions of representatives of extant genera observed in the fossil record contrasted markedly with the dimensions of present day fauna, and the term 'megafauna' was applied to marsupials of the past era, as it was to the extinct giant eutherian mammals of the northern hemisphere and the Americas. The size range of marsupial carnivora spanned diminutive dasyurids, through intermediate sarcophylids and thylacinids, and at the top of the food chain, with the capability of preying on even the largest macropodids and diprotodontids, was the remarkable creature *Thylacoleo carnifex* (Owen), the Marsupial (or Pouched) Lion. However, the process of interpretation leading to this conclusion was by no means uncontroversial.

The earliest knowledge of the existence of a lion-sized marsupial predator in Australia's prehistory was due to the analytical skills of Professor Richard Owen, who was presented with fossil teeth of an unusual nature by Major Thomas Mitchell in the 1830s. The fossil material was collected from the Wellington Valley area of New South Wales, having been gathered during the famous explorer's expeditions. Initially, Owen was unable to offer a solution to their identity. 'I could not, at that date, determine the affinities of the Australian mammal yielding such a tooth' (Owen 1877: 107). It was to take another 30 years for some clarity about the nature and 'affinities' of the enigmatic creature to emerge.

Subsequent fossil material from a tributary of the Condamine River, Queensland, and another find in 1846 from Lake

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Fig. 1. Thylacoleonid teeth and bone fragments sent to Owen in 1837 (from Owen 1877, fig. 1, plate VI).

Colungulac, Western Victoria, enabled Owen to begin to define the species and its habits (Fig. 1).

Following a lengthy analysis of the 'singular' but still tantalisingly incomplete fossil material he had at his disposal, Professor Owen summarises …

> and the chief conclusion as to the affinities of the animal to which they belonged, had been indicated by the term *Thylacoleo*, i.e. Marsupial or Pouched Lion, which conclusion was based on the characters and comparisons of those fossil remains detailed in the foregoing pages.
>
> The concurrence in them of so many cranial characters found only in the Marsupialia, will be deemed, I apprehend, demonstrative of the marsupial nature of *Thylacoleo*; and, amongst existing Marsupialia, the *Sarcophilus* or *Dasyurus ursinus* - at present the largest existing species of its genus - seems to me to have the nearest affinities to *Thylacoleo*, although the interval be still very great between them (Owen 1877: 120-121).

After examining additional fossil material, Owen became convinced that *Thylacoleo* was a carnivorous representative of the diprotodontids (Owen 1877: 131). By virtue of its extraordinary dental and cranial characteristics, he determined that this was a powerful, highly specialised carnivore.

> In existing carnivorous mammals, the ferocity of the species is in the ratio of 'carnassiality' of the sectorial molar, i.e. of the predominance of the 'blade' over the 'tubercle' … From the size and form of the carnassials of *Thylacoleo*, especially of the upper one, we may infer that it was one of the fellest and most destructive of predatory beasts (Owen 1877: 119).

Some 30 years later, Frederick McCoy received complementary thylacoleonid fossil material from the Lake Colungulac source in Western Victoria. Thus he became engaged in the process of interpretation of characteristics of this intriguing animal, and later contributed to the debate that had been raging amongst palaeontologists of the time, following the controversial published views of Professor Owen.

The problem of interpretation was heightened by the distinctive nature of the fossil teeth. Unusually large and well pointed incisors were complemented by extraordinary long shearing premolars resembling an efficient guillotine-like mechanism. Associated with these were two pairs of lesser incisors, small conical canines and, posterior to the large premolars, almost vestigial molars. This strikingly unusual dentition belonged to an animal with a heavily boned skull structure similar in size and musculature to a large pantherid such as the African Lion, to which Owen soon compared it (Owen 1877). Nothing was then known of the body structure of the animal, but by the time Owen had satisfied himself that he was dealing with a carnivore, some phalanges (toe and claw fragments) had been discovered and again they supported the flesh-eating hypothesis.

Owen noticed similarities in the dentition of *Plagiaulax* sp. (Owen 1877), a small carnivorous marsupial from known British Mesozoic fauna, to that of *Thylacoleo*, and it was this observation that led him strongly toward the marsupial carnivore diagnosis. *Plagiaulax* was determined to be a small, early mammal adapted to preying on small reptiles. It too exhibited stabbing incisors and shearing premolars (Fig. 2), indicating a high degree of 'carnassiality' (Owen 1877).

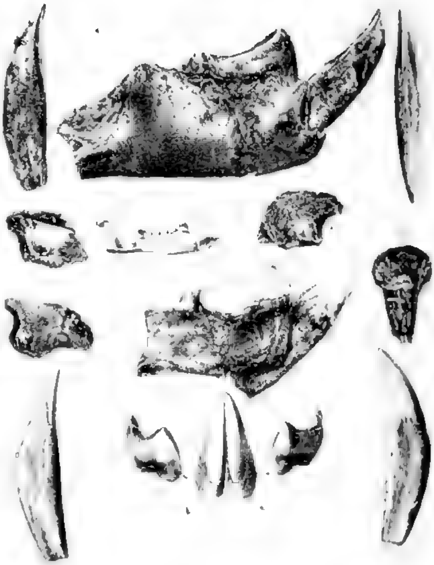

Fig. 2. Thylacoleonid teeth and mandible fragments which Owen compared to *Plagiaulax* shown (Fig. 10) on this plate (from Owen 1877, plate IX).

Owen presented his findings to the Royal Society of London, 15 June, 1865, and subsequently analysed and answered 'Objections to The Author's Determination of The Nature and Habits of The Species' (Owen 1877: 133).

> .. several eminent and experienced investigators of fossil remains have endeavoured to determine to which of the groups … the *Thylacoleo* was most closely or immediately allied. Some have been led to the belief of its having been a Kangaroo, some have deemed it a Potoroo or Rat-Kangaroo, others would rank it with the arboreal Phalangers or Koalas; but all concur in repudiating its carnivorous character, having rejected the distinct section of Diprotodont Marsupials, of which *Thylacoleo* and *Plagiaulax* are exemplars, and have sought, with more or less ingenuity, to invalidate the conclusions which I have been led to deduce from the parts of the fossilized remains of those paucidentate Marsupials which at that date, had been submitted to my examination.

McCoy is not mentioned in this discussion, although it is clear from McCoy's (1862) *Prodromus* and other papers dealing with *Thylacoleo*, that he had no problems with Owen's carnivorous interpretation of thylacoleonid fossil material. One would think that Owen would have appreciated unequivocal support from a highly ranked colleague when it is considered that counter-arguments and conjecture regarding thylacoleonid affiliations and habits continued well into the 1900s. The following excerpt from McCoy's *Prodromus* indicates his clarity on the issue of carnivority, although his decision to describe the fossil material in his possession as a new thylacoleonid species was later deemed to be erroneous.

> There is no fossil animal yet described [that] has excited so much interest and given rise to so much animated controversies as that named the 'Marsupial Lion' by Professor Owen, from the general resemblances, on a greater scale, which the teeth of this marsupial animal show to those of the lion, and indicating, in his opinion, a similar predacious habit in each.

The tone of McCoy's expression gives an indication of his interest and enthusiasm for unravelling the mystery and debate surrounding the remains of *Thylacoleo*. Further, McCoy clearly sides with Owen in dismissing the opposing views of his detractors.

> Dr. Falconer, Mr Flower and others, have advocated, with singular zeal, the opposite view, that the creature was a harmless vegetable feeder … overlooking the fact that these latter have a series of grinders of the ordinary type of vegetable feeders, behind the compressed premolar, while all the teeth are of the carnivorous type in the Marsupial Lion (McCoy 1876: 8).

McCoy received vital thylacoleonid fossil material from Mr Richard Adeney in 1876, found at Lake Colungulac (80 miles west of Melbourne) on his own property. It was suspected that the fossil material delivered to McCoy (Fig. 3) was part of the same skeleton that Adeney had found in 1846 when he provided incisor and premolar teeth along with fragments of the skull of a specimen which he had forwarded to Owen.

> A few months ago Mr Adeney brought to me the specimen figured in the upper part of our plate from the same spot, and so entirely completing the anterior part of the skull and teeth absent in the skull he found

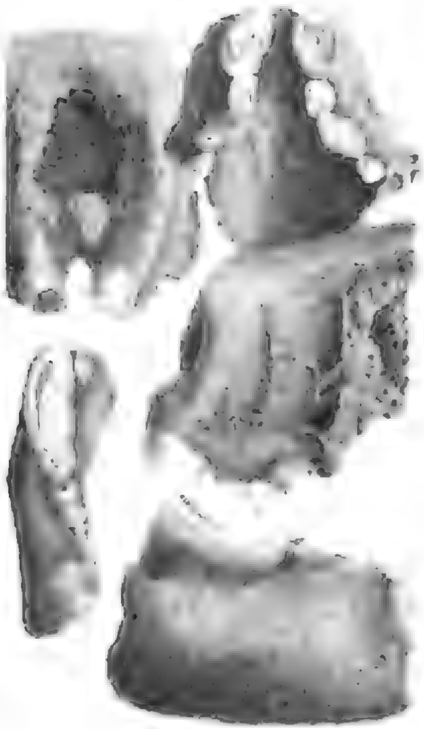

Fig. 3. Thylacoleonid fossil material supplied to McCoy by Richard Adeney, showing most of the teeth *in situ* (from McCoy 1876, plate XXI).

> nearly 30 years ago and sent to Professor Owen, that he supposed it might have belonged to the same individual (McCoy 1876: 9).

McCoy was emphatic about the importance of this material. 'Our present specimen is therefore the only one as yet made known exhibiting all the teeth in front of the carnassial in the upper jaw *in situ*' (McCoy 1876: 9).

He concluded that there was sufficient difference between this and another NSW specimen (from Wellington Caves) examined by Owen, to distinguish the Victorian fossil material as a new species, *Thylacoleo oweni*.

In his *Prodromus*, Decade III, McCoy put forward the following basis for that argument.

1. The longer convex margin of the third incisor was posterior in *T. carnifex* but reversed in *T. oweni*.
2. The position of the premaxillo-maxillary suture (seam or junction) in relation to the roots of the canine tooth and third incisor was significantly different (Fig. 4) (comparing NSW to Victorian source material).
3. The depth of the mandibular ramus (principal bone section) in the region supporting the shearing premolar (P3) and first molar (M1) was greater toward the front in the Victorian specimen, and toward the rear in the NSW specimen.
4. The palate was narrower and longer in the Victorian specimen.
5. The first and second incisors and the canines were larger in the Victorian specimen.

McCoy's exhaustive analysis thus led him to believe he was justified in naming a new species, *Thylacoleo oweni* (McCoy 1876: 7-11), but it was not long before Owen (1877) rejected the first two points on the basis of:

1. His own initial interpretation of the orientation of the third incisor was based on detached teeth. This was later corrected after receipt of more complete fossil material.
2. Uncertainty over identity of the third incisor and canine (for similar reasons to above) was also cleared up after examination of further material.

Later, more detailed analysis (Archer and Dawson 1982; Finch 1982) confirmed that all of the points of distinction raised by McCoy were within the range of variability found in the now extensive *Thylacoleo* fossil collection from the Wellington Caves area of NSW This showed conclusively that there was no longer any justification for maintaining that different species existed in Victoria and NSW

However, on-going research by modern-day palaeontologists has confirmed the family Thylacoleonidae is represented by at least nine extinct species, incorporated in three genera (Gillespie 1999). The oldest and smallest is *Priscileo*, known from specimens representing two species from late Oligocene and early Miocene deposits. The 'mid-sized' *Wakaleo* is known from fossil material of late Oligocene to late Miocene sources, representing four species (Gillespie 1999). Three species of *Thylacoleo* have thus far been identified. *T. hilli*, the smallest and oldest, is known from late Pliocene origins, and was known

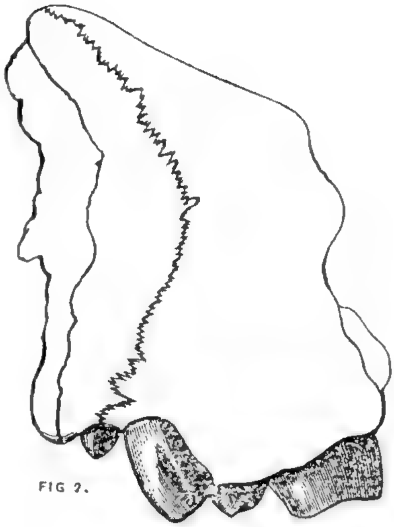

Fig. 4. 'Reduced side view showing direction and character of the premaxillo-maxillary suture dividing the socket of the canine' (from McCoy 1876, fig. 2, p. 10).

to have coexisted with the larger *Thylacoleo crassidentatus*. The most recent, and by far the largest representative, was *Thylacoleo carnifex*, known from early to late Pleistocene (Archer and Dawson 1982; Gillespie 1999). The most recent fossil material appears to be that originating from a cave near Montague, north-west Tasmania, which is dated at approximately 10,000 years bp (Finch and Freedman 1982; Murray and Goede 1977). Along with the apparent progressive increase in size of thylacoleonids from the late Oligocene to the late Pleistocene, there is also a progressive increase in the degree of specialisation of their dental characteristics. This reached a peak in *Thylacoleo carnifex* with its huge shearing premolars (up to 5 cm long), that moved Owen to describe it as 'the fellest of beasts.' (Owen 1877).

Detailed studies of the structure and development of wear patterns on the teeth of *Thylacoleo carnifex* (Wells *et al.* 1982), confirmed once and for all, that 'All evidence pointed to a flesh-eating marsupial of diprotodontid ancestry,' not a plant eater. In this study, they compared the striations produced by the passage of food across the tooth enamel of known carnivores and herbivores, with reference to similar markings on the teeth of *Thylacoleo* (Wells *et al.* 1982). This enabled them to clearly define the piercing function of the first incisors, as well as the shearing function of the carnassials (premolars). An extraordinary adaptation, peculiar to *Thylacoleo* amongst mammalian carnivores, is the apparently unfused ramus (mandible), providing for a 'flexible symphysis' (Wells *et al.* 1982). This allows for limited rotation of the lower premolars about the longitudinal axis, optimising the interface angles of the upper and lower shearing surfaces during jaw closure. It also implies the possibility of separation of the lower incisors into an open 'V' during delivery of the powerful piercing bite, perhaps providing a more secure hold on prey than had been previously postulated.

The analysis of more recent finds of post-cranial material, particularly a near complete skeleton found at Moree, NSW in 1966, has enabled palaeontologists to determine the general appearance and to speculate on the habits and lifestyle of this most unusual predator. Recent empirical research based on skeletal dimensions, particularly circumference of femur and humerus of the Moree specimen (Wroe *et al.* 1999), clearly indicates that *Thylacoleo carnifex* lived up to the pronouncements and expectations of Owen, in that it rivalled the African Lion in size, weight and strength. The method was considered reliable in predicting weights of living and extinct fauna, enabling the research team to conclude that this formidable carnivore, sometimes topping 160 kilograms in weight, was most likely a big game specialist with the capability of killing even the diprotodontids (Wroe *et al.* 1999).

The complete profile of this top carnivore is still emerging from continued study of fossil material from more diverse sites. The spinal column has been described as robust but flexible, with a strong neck, supporting a large head (Finch 1971). We now have a picture of a heavily built quadruped with relatively long limbs, exceptional musculature, a long flexible tail and perhaps a lithe, cat-like overall appearance. Aboriginals of the 'dreamtime' who had the dubious privilege of encountering this snarling beast would have perceived large, forward-set eyes providing good binocular vision, huge ice-pick incisors and extraordinary blade-like carnassials in an animal that possibly had agility commensurate with its pantherid size and approximate conformation (Fig. 5). Haunting impressions of the legendary 'drop bear' are brought to mind.

The five-toed front paw structure incorporated a very heavy first digit with large hooded claw, which was opposable toward the wrist (Wells and Nichol 1977). There are indications that the claws are partly retractile, and if so this takes an already apparent evolutionary parallel with the big cats to another challenging level. These adaptations would have served just as well in grasping prey as in climbing trees, so both applications have been considered to be within the range of accomplishments of this Pleistocene hunter. The hind foot has been described as possum-like with an opposable first digit, which again suggests arboreal capabilities (Wells 1985). Recently it has been suggested that the size and weight of *Thylacoleo carnifex* counts against an arboreal inference (Wroe *et al.* 1999). However, some consideration must be given to the recent discovery of excellent tree climbing skills of adult male Lowland Gorillas *Gorilla gorilla gorilla*, that can weigh upwards of 200 kg. This unexpected behavior has recently been filmed in Congo rainforests (BBC Wildlife, 2001), and highlights the importance of grasping adaptations that would seem to have advantaged *Thylacoleo* in any arboreal aspirations. Finally, with the combination of digitigrade stance on the front paws, and possibly plantigrade hind feet, it has been suggested that *Thylacoleo* could have had a good turn of speed, at least in short bursts, in pursuit of its prey (Finch 1982).

Thylacoleo fossils have now been identified in nearly every major late Pleistocene fauna site in Australia (Wells 1985), but usually in small numbers compared to herbivorous representatives of the marsupial megafauna. This is in keeping with a top carnivore's predator/prey population dynamics. The major exception is Victoria Cave, Naracoorte SA (Wells 1985; Wells and Nichol 1977) where numerous near complete skeletons have been identified in one precise location.

Some conclusions regarding predation have been drawn from associations between thylacoleonid fossil remains and possible prey species found at the same locations. *Sthenurine* kangaroo bones have been found with grooves corresponding to the distinctive dentition of *Thylacoleo* (Horton and Wright 1981). Similar occurrences from other fossil sites dating back to the 1800s (DeVis 1883) supports this conclusion. A diprotodon femur exhibiting compelling evidence of two biting attacks (indicative of *Thylacoleo*), from two directions, with subsequent evidence of healing (Scott and Lord 1924), represents the only current evidence of *Thylacoleo* preying on live megafauna (Fig. 6). Evidence contin-

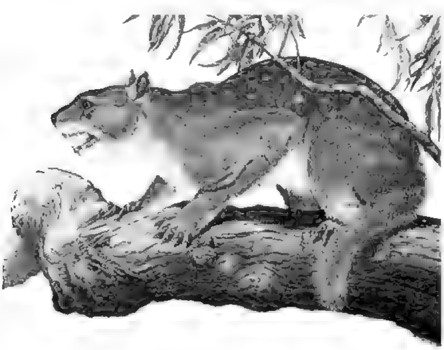

Fig. 5. *Thylacoleo carnifex* depicted in this interpretation by scientific illustrator Peter Schouten as arboreal and distinctly cat-like. From Finch (1983). Reproduced with permission.

Fig. 6. *Thylacoleo carnifex* depicted preying on *Procoptodon* by scientific illustrator Peter Schouten. From Finch (1983). Reproduced with permission.

ues to grow in support of the logic and deductive processes of Owen and McCoy more than a century ago.

The picture has finally come together of a widespread, powerful and highly successful predator, possibly with related species occupying a range of ecological niches provided by the incredible diversity of the associated megafauna, as in the realm of the felids of the northern hemisphere. Evocative as this image is of a Pleistocene marsupial paradise, it was shattered by the mass extinctions corresponding to the end of that Epoch, and, for reasons yet to be determined, the apparently adaptable family of thylacoleonids went into oblivion along with the lost marsupial giants.

This brief review of the part played by Frederick McCoy in unravelling the phylogenetic associations and feeding preferences of *Thylacoleo carnifex* (Owen) has led us to an appreciation of his clarity in supporting Owen's original determination of a carnivore of diprotodontian 'affiliations.' Many of his contemporaries who staunchly advocated alternative theories have progressively been proven wrong by the application of modern scientific methods. However, those early counter-arguments occupied present day palaeontologists well into the 20th century before they could be unequivocally put to rest.

McCoy's apparent haste in proclaiming *Thylacoleo oweni* as a distinct species may have signalled his anticipation that relatives of Owen's Marsupial Lion could have had a place in the diverse fauna of the Pleistocene.

Acknowledgements

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M'Coy and the Australian Ichthyosaur *Ichthyosaurus australis* (M'Coy, 1867)

A.J. Hell[1]

Abstract

The first Australian ichthyosaur fossils were described by Frederick M'Coy in 1867 from a series of fossil specimens collected by James Sutherland in the Flinders River region, northern Queensland. An initial case of fossils collected was primarily used by M'Coy to provide the first incontrovertible proof of the existence of the Cretaceous System in Australia. Subsequent follow-up work was undertaken and further specimens were collected, including fossil vertebrae that were named by M'Coy, *Ichthyosaurus australis* (M'Coy 1867). Despite describing the species as 'the most interesting fossil animal yet found in Australia' his descriptions were brief and limited and have been criticized by a number of later workers. (*The Victorian Naturalist* **118** (6), 2001, 294-297.)

Frederick M'Coy's description of the first ichthyosaur fossils in Australia (M'Coy 1867a) (Fig. 1) are generally considered to be an important contribution to Australian vertebrate palaeontology. The three boxes of fossil material M'Coy described were collected by James Sutherland during the period from early January 1865 through to November 1866 (Sutherland to M'Coy 1865 & 1866). The fossils were all collected from the Flinders River region at Lat. 21° 13'S and Long. 143° 25'E (M'Coy 1865), north Queensland and as described by Sutherland were,

> collected between Walker & O'Connell Creeks left bank of the river. (See Landsborough Map) in the dry channels & water courses but principally on the slopes of the undulations or ridges & outer summits lying detached in the loose earth (letter from Sutherland to M'Coy, 7 October 1865).

Despite M'Coy being held in high regard for his contributions to Irish, British and Australian palaeontology, his published works on the Australian ichthyosaur does little to enhance his reputation.

Based on his brief and limited descriptions and lack of illustrations, it is apparent that this was a hasty attempt to record and document a new species and its implications for the recognition of the Cretaceous System in Australia. Many workers (Etheridge 1888, Longman 1922 and Wade 1984a; b; 1990) involved with researching the Australian ichthyosaur are critical of M'Coy's published works. McGowan (1972) suggested that Etheridge's (1888) work on ichthyosaurs, in which he gives a very detailed description of his material and erects a new species, was 'probably out of the sense of frustration and despair at trying to compare this material with M'Coy's' (McGowan 1972). For the contemporary worker it is not easy to decipher and relate M'Coy's descriptions to the specimens that he described. It is especially difficult to identify from the collection the original type fossil vertebrae (M'Coy 1867a, Sutherland to M'Coy 1866). Furthermore, the present author examined and separated what are assumed to be the original fossil vertebrae, and found many inconsistencies with M'Coy's measurements. However, with much patience, it was found that some of the specimens match M'Coy's descriptions, but overall his work is notably vague and 'meagre' (Etheridge 1888).

The ichthyosaur species described by M'Coy was considered by him to be the 'most interesting fossil animal yet found in Australia' (M'Coy 1868b), suggesting that his descriptions were only preliminary and given simply to acknowledge existence of the species in the country. If we were to compare this work with much of his other works, one may assume that M'Coy intended to undertake further detailed and illustrative contributions on the ichthyosaur fossils. Unfortunately however, probably based on many contingencies, further published works were not undertaken, and therefore what remains is a significant but sketchy description.

The first case of Sutherland's fossil specimens described by M'Coy (1865), as far as the author is aware, did not contain

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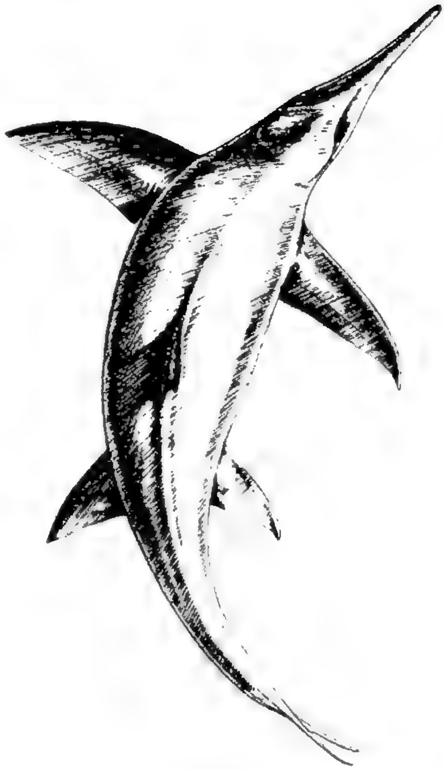

Fig. 1. *Platypterygius australis*. Interpretation of a Australian Cretaceous ichthyosaur 'after the Telemon specimen and others. Length over all 5.6m' (Wade 1984a).

ichthyosaur fossils and essentially comprised molluscs, ammonites and fish vertebrae. These specimens, however, occurring in 'an olive calcareo-argillaceous marl' (M'Coy 1866), played an important role in Australian geology, allowing M'Coy to indisputably confirm for the first time in Australia the Cretaceous formation (M'Coy 1865; 1866). Shortly after this recognition, Sutherland carried out further collection work in the same area. During this time Sutherland made a discovery of fossil vertebrae which he believed to be 'saurian'. Among the specimens collected by Sutherland, the vertebrae sections were considered of significance, about which he wrote to M'Coy on the 7 October 1865,

> The collection now on its way will I think determine the age of the formation. It's a certainty; it consists – chiefly of molluscs, fishes and reptiles. The most remarkable are to me vertebral joints from 3 to 4 inches diameter, probably Saurian.

M'Coy first published on his material in England, and possibly pressured by the nature and timing of 'sailing ship mail runs' (Wade 1984b) he presented an initial brief and hasty description of the species. However, as Sutherland indicated to M'Coy (Sutherland to M'Coy 1865) the initial collection of ichthyosaur vertebrae including other fossils were likely to be delivered by the end of December, 1865. This would have given him adequate time for a detailed description, but of course it is possible they arrived much later. M'Coy's first publication on the species entitled: 'On the Occurrence of Ichthyosaurs and Plesiosaurs in Australia' was published in the *Annals and Magazine of Natural History* (M'Coy 1867a), which he later presented in the *Transactions and Proceedings of the Royal Society of Victoria*, entitled: 'On the Discovery of Enaliosauria and other Cretaceous fossils in Australia' (M'Coy 1868a). Due to the nature of communication and travel time, further information on more ichthyosaur specimens (Sutherland to M'Coy 1866) collected by Sutherland, did not reach M'Coy prior to his first publication.

M'Coy received a third and final collection of ichthyosaur specimens from the same area, sent by Sutherland in November 1866. This collection was the most significant, and comprised more discernable skeletal material including two skull sections (Fig. 2), sections of vertebrae, rib bones, paddle fragments and a section of the jaw with exposed teeth (Fig. 3). Both M'Coy and Sutherland's recordings and descriptions, were limited in part, making it difficult to contrast and compare information to the actual type material. The entire collection, with original sample numbers 48 and 60, can be viewed in the Museum of Victoria. Wade (1984a) stated that M'Coy's description was such that, '... it is imposible to discover that it contained two skulls'. After examinng the type material, the author believes that M'Coy thought the two specimens (MV P12990 and P12989) belonged to the one skull. However, it remains an open question as to whether the two skull sections are from the same individual.

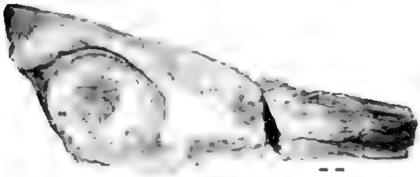

Fig. 2. *Ichthyosaurus australis* (M'Coy 1867). Two sections of the skull displaying the characteristic large eye with well preserved sclerotic plates, MV P12990 and P12989.

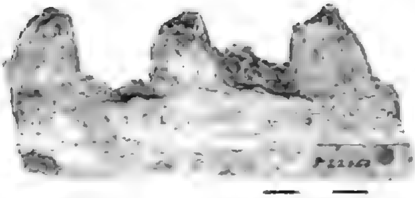

Fig. 3. *Ichthyosaurus australis* (M'Coy 1867). Section of jaw with exposed teeth, MV P22653.

M'Coy's final publications on the Australian ichthyosaur were based on the skull, forelimb and other vertebrae sections. He published these findings in the *Intercolonial Exhibition of Australasia, Official Record* (M'Coy, 1867b) later reprinted in the *Annals and Magazine of Natural History* (M'Coy 1867c). Descriptions of these additional specimens were also published in the *Transactions and Proceedings of the Royal Society of Victoria*, entitled: 'On the Fossil Eye and Teeth of the *Ichthyosaurus australis*, (M'Coy), from the Cretaceous formations of the source of the Flinders River ...' (M'Coy 1868b).

The more notable aspects of M'Coy's descriptions in the later publications were his interpretation of the form and functional morphological characteristics of the species. 'Some bones now exhibited prove this species to have been one of the largest of its genus, one individual being from analogy, (25) feet in length' (M'Coy 1868b). Furthermore, referring to the paddle fragments, 'it has (8) eight rows of phalangeal bones, and as one edge is imperfect, it may have had more; it is thus one of the most powerful swimmers of the genus' (M'Coy 1868b).

The first published illustrations of M'Coy's type specimens were figured by Chapman (1914) who illustrated one each of the skull (MV P12990) and forefin fragments. Anderson (1934) and McGowan (1972) later figured M'Coy's material. It is conceivable that M'Coy may have intended at a later date to produce a more comprehensive work including illustrations of the type specimens. However, there is no evidence to support this.

M'Coy's work on the Australian ichthyosaur has been criticized by a number of past and contemporary workers. Although M'Coy's overall contribution to taxonomic palaeontology is extensive and praiseworthy, his work on the Australian ichthyosaur appears to be brief and limited. It is possible that M'Coy saw his descriptions only as preliminary and that he intended, if time and finances permitted, to carry out a more considered and accurate examination of the fossils in question.

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Animal Acclimatisation: McCoy and the Menagerie That Became Melbourne's Zoo

Linden Gillbank[1]

Abstract

Frederick McCoy's mid-nineteenth century zoological interests included animal acclimatisation. He helped shape the menagerie in Mueller's Botanic Gardens and later in the Acclimatisation Society of Victoria's Royal Park depot, where it grew into Melbourne's zoo. He was particularly interested in three animals shipped from India - the Cashmere goat, Arrindy silkworm and Indian Minah. (*The Victorian Naturalist* **118** (6), 2001, 297-304.)

Introduction

Frederick McCoy is known as a university professor and museum director, but his involvement in another institution Melbourne's zoo -- is less well-known. He helped shape its presumptive menagerie - a transient collection of animals awaiting permanent homes elsewhere. These animals were not primarily for display. They were brought into the young colony of Victoria by a society dedicated to the introduction of useful and ornamental animals and plants, in the hope of enriching the purses and psyches of immigrant colonists birds that would sing sweetly or consume fruit-attacking insects, fish for Victoria's rivers, and game and grazing animals for bush and paddocks.

McCoy's mid-nineteenth century acclimatisation interests and activities, as revealed in zoological and acclimatisation society records, provide glimpses of the origins of Melbourne's zoo and of the global acclimatisation movement. They contrast starkly with current environmental and ecological ideas.

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Acclimatisation

As Victoria's gold production declined during the 1850s, new rural industries were sought. What could graze or grow in the colony? And there was nostalgia. So far from the sights and sounds of European 'home', immigrant Victorians wanted to hear the skylark and nightingale, and see and shoot deer, pheasants and partridges. 'New' useful and attractive animals were eagerly sought for pleasure and production.

The Acclimatisation Society of Victoria was established in 1861 to fulfill these economic and nostalgic desires. At its Royal Park depot sea-weary animals recovered prior to their distribution across the colony. A lifelong member, McCoy served on the Acclimatisation Society's Council from 1861 until 1872, the year that Zoological was added to the Society's title. The Council acknowledged its great indebtedness to McCoy 'who in spite of the multifarious calls upon his time and attentions has always rendered to this Society services of a valuable and scientific character' (ASV 1864: 12), and that the vice-presidency was 'unanimously conferred upon Professor McCoy, who has been a warm friend to acclimatisation from the very first in this country' (ASV 1866: 5).

Agreeing to give the Society's first annual address in November 1862, McCoy presented his ideas on acclimatisation (ASV 1862: 36-9). It did not, he said, necessarily mean the possibly difficult alteration of a creature's tolerance to different climatic or geographic conditions, but rather

> the bringing together in any one country the various useful or ornamental animals of other countries having the same or nearly the same climate and general conditions of surface.

On a map of the world he pointed to places, separated by climatic or geographic barriers, which were inhabited by similar animals – the 'representative species' created there – and displayed museum specimens of them. The acclimatiser could 'bring with the absolute certainty of success *all* the representative species of any group into *each* of the localities'. This, he said, was 'the first great principle involved in successful acclimatising'.

He presented a gastronomical glimpse of biological diversity:

> Of the quadrupeds useful for food, by far the largest number and most important to the acclimatiser, belong to the great group of ruminating animals which chew the cud, and have a cloven foot.

So many ruminants occurred within Australian latitudes on other continents. The fifty in India included 'upwards of twenty species of deer, six antelopes, and various species of sheep, goat, ox, &c', and South America provided 'three species of llama and alpaca, eight species of deer, and a goat'. But it was an 'extraordinary fact'

> that while Nature has so abundantly furnished forth the natural larder of every other similarly situated country on the face of the earth with a great variety, and a profusion of individuals of ruminants good for food, *not one single creature of the kind inhabits Australia*!

Furthermore

> If Australia had been colonised by any of the lazy nations of the earth, this nakedness of the land would have been indeed an oppressive misfortune, but Englishmen love a good piece of voluntary hard work, and you will all, I am sure, rejoice with me that this great piece of nature's work has been left to us to do.

The young society had grand intentions and much to do.

Melbourne's Menagerie – alpacas but not lions

Before the birth of Victoria's acclimatisation society there were various attempts to introduce animals new to Victoria, including those of Edward Wilson (co-owner and retired editor of the Melbourne *Argus*) in Victoria's Philosophical Institute and in England (Gillbank 1996a). And there was an impecunious zoological society which was unable to keep its growing menagerie.

Soon after its formation in October 1857, the Zoological Society of Victoria was promised money and granted land in Richmond Paddock north of the Yarra. When a later government refused to honour its predecessor's substantial pecuniary promise, the Society was unable to convert its land into zoological gardens, leaving its assorted animals high and dry across the Yarra in the Botanic Gardens. After much worrying, discussing and not paying the labourers who dug and fenced its swampy site, the debt-ridden Zoological Society handed over control of its land and animals to the government, which then agreed to provide funding; and government and Zoological Society representatives were appointed to a management committee (Gillbank 1996b).

McCoy was one of four government appointees to the Zoological Gardens Management Committee which, from July 1858 to August 1861, held monthly meetings in Dr Ferdinand Mueller's office in the Botanic Gardens, and later in Melbourne's Mechanics Institute. Mueller, the government botanist and director of the Botanic Gardens, was the Zoological Committee's honorary secretary, whose minutes of meetings record McCoy's attendance at seven meetings and his comments on lions, glow worms and a ruminant – the Cashmere goat.

At the Zoological Committee's first meeting in July 1858 McCoy

> expressed his great desire of seeing in future the botanic and the zoological Gardens combined, in as much as he regarded the higher and already planted grounds of the botanic Gardens more suitable to the health of the generality of the Quadrupeds.

After the October meeting's resolution to combine the two grounds, Melbourne's Botanic Gardens gained land as well as animals and Mueller signed his annual reports as director of the botanic and zoological gardens.

In 1858 McCoy was also a member of the Exploration Committee of Victoria's Philosophical Institute (Royal Society from 1860) which wanted camels for the grand transcontinental exploration expedition it was organising (Bonyhady 1991). He chaired the Zoological Committee's August meeting which agreed that camels should be acquired and heard George Landells' offer to import them. In December 1858 the Zoological Committee discussed the claim of the enterprising entrepreneur of Cremorne Gardens Amusement Park in Richmond, George Coppin, that he had two lions for the Zoological Society and was awaiting payment. On McCoy's suggestion the Committee decided to investigate his claim. Later they decided against accepting the lions.

While it was difficult to find money for such impressive animals as lions, government money was available for the introduction of useful ones – £500 in 1860. McCoy chaired the Zoological Committee's June meeting which welcomed Landells' arrival with 24 camels. On 20 August 1860, while Melbournians flocked to Royal Park to farewell these very useful animals with Burke and Wills, and the rest of the over-encumbered expedition, the Zoological Committee heard from another animal trader, Charles Ledger, offering to import alpacas. They decided to seek government money for Chinese sheep and Cashmere goats, but not alpacas. McCoy successfully proposed that £200 should be sought for the introduction of Cashmere goats, which because of their wonderful wool were also called shawl goats. In October Mueller reported payment of £200 to Messrs Grice, Sumner & Co (the Melbourne merchant firm of the Committee's honorary treasurer, T.J. Sumner) for their importation.

Alpacas also produce fine wool. In 1859 the Zoological Committee received a mixed llama-alpaca flock which Edward Wilson sent from England (Gillbank 1996b). Unfortunately, unlike the NSW flock which Ledger spent a very difficult decade collecting in Peru and smuggling across the great South American Cordillera (Gramiccia 1988), the Committee's flock contained very little alpaca. In October 1860 Ledger brought two male alpacas to breed better wool into the Zoological Committee's flock, and joined the Committee's deputation seeking government money for alpaca importation. McCoy chaired the November meeting which heard that the Chief Secretary had promised to bring the matter 'under the favorable notice of the Cabinet and to place the requisite sum on the estimates'. The subsequent granting of the huge sum of £2000 was a hopeful beginning to the sorry saga of Ledger's blighted attempt to bring alpacas to Victoria, as revealed in Zoological Committee minutes and by Gramiccia (1988).

By the end of 1860 Melbourne's Botanic Gardens supported an interesting menagerie. In his annual report Mueller (1861:10) recorded the following exotic and indigenous animals:

> Llamas, Angora goats, fat-tail sheep, elk, fallow deer, Sumatra deer, Ceylon deer, four species of monkeys, kangaroos, wallabys, two species of kangaroo-rats, English squirrels, two species of flying squirrels, two species of Australian opossum, Indian screwtail, native bears, Indian and Australian porcupines, wombats, watermoles, emus, white and black swans, Chinese geese, Muscovy ducks, spoonbill ducks, Cape Barren geese, one Indian pelican, native companion, one Indian heron, curlews, laughing-jackass, magpies, three species of native owls, three species of native hawks, Australian eagles, Murray pheasants, silver pheasants, British pheasants, Manilla and two species of Feejee doves, ring-doves, bronze-winged pigeons, Indian mocking birds, Indian and British partridges, hedge-sparrows, linnets, canary birds, skylarks, goldfinches, siskins, blackbirds, thrushes, Java sparrows, Australian and Californian quail, one iguana.

And perhaps there were glow worms. For several years Edward Wilson was very busy in England orchestrating the transmission to Melbourne of an amazing variety of creatures, and in 1860 sent glow worms. At the Zoological Committee's November meeting McCoy suggested that some be liberated in the Botanic Gardens and some hatched at the National Museum of Victoria in the University grounds, where he later found a missing but apparently acclimatised one in full glow (ASV 1862).

As an increasing diversity of animals reached Melbourne's Botanic Gardens another site and another society were in the minds of their managers. As Landells' camels left their Royal Park stables on the ill-fated expedition, Royal Park was considered as an alternative site for zoological gardens (Gillbank 1996b). But Edward Wilson, the font of much acclimatisation wisdom and activity, was still in England. On his return a new society devoted solely to acclimatisation could be established. At a special meeting on 27 February 1861 the Zoological Committee reconstituted itself the committee of the Acclimatisation Society of Victoria, which two days earlier had been formed at a public meeting presided over by the governor, Sir Henry Barkly.

From February to August 1861 acclimatisation activities and animals were transferred to the new committee. After attending the Zoological Committee's May meeting which resolved to ask the Chief Secretary for the large sums recently granted for acclimatisation – £2000 for the introduction of alpaca, £500 for salmon and £500 for other useful animals – McCoy attended the Acclimatisation Society's committee meeting which, not surprisingly, decided that this money should be made available to them. Minutes of the Zoological Committee's last meeting in August 1861 record the transfer from the Botanic Gardens to Royal Park of Angora goats, Chinese sheep and llama-alpacas, and consideration of 'the cession of the Royal Park to the Acclimatisation Society'.

The Acclimatisation Society of Victoria (ASV) and a goat, a silkworm and a bird from India

At a public meeting in August 1861 Edward Wilson was appointed president and Mueller vice president of the Acclimatisation Society of Victoria (ASV). McCoy was a committee member of the ASV Council and Governor Barkly agreed to be patron. The ASV attracted thousands of pounds of government money and hundreds of members. Consuls were made honorary members. ASV Council meetings were held in the Society's city office or sometimes in the Camel House at Royal Park before inspecting the menagerie.

The minutes of its weekly meetings reveal how busy the ASV Council was – organising the importation of a great diversity of useful animals, their transient accommodation at Royal Park, and their transfer to land, water and sky elsewhere in Victoria. The ASV's primary object was not a fascinating zoological display at Royal Park, but rather the distribution of creatures across the colony. At its Royal Park depot newly-arrived animals recovered from long and often debilitating sea voyages, and, if possible, reproduced. Breeding was important because successful acclimatisation required enough individuals to sustain viable populations in their new homes. If Royal Park was not suitable, breeding grounds elsewhere were sought. Death was not wasted. Animal corpses became stuffed specimens in the National Museum of Victoria. Lucky McCoy!

In the early 1860s McCoy attended about half the ASV Council meetings, during which he shaped resolutions and participated in subcommittees. His successful resolutions in 1862 included

> That £500 be placed at the disposal of the President in Europe ... for the purchase of birds and quadrupeds likely to thrive and do well when turned out in the colony [20 May];
>
> That a paragraph ... be inserted in all letters to foreign correspondents, viz ... that the Council are very desirous of obtaining chiefly animals and birds of an economically useful character, and those native birds already domesticated in your locality whether for ornament, song or use, and examples of the game of your country are most particularly desired [17 June];
>
> That no imported animals of useful or ornamental kinds be sent out of the colony in the way of exchange unless where such imported specimens have been procured by the Society as authorised agents for other governments or persons [30 December].

In 1862 McCoy was appointed to subcommittees to enquire and report as to the most suitable locality for a breeding camel park, preparatory to an application to the Government for a grant of land for that purpose [3 June];

to visit the [Royal] Park and report to the Council upon the present arrangements in force there and to make any suggestions to the Council they may deem advisable [26 August];

to visit the Park and report what animals can be got rid of as useless and how far the present expenditure can be reduced [2 October];

to report to the Council on those animals for the introduction of which it is most desirable at present to expend the funds of the Society [9 December].

McCoy's resolutions and sub-committees indicate the thrust of the ASV. Council minutes also reveal McCoy's acclimatisation interest in three creatures shipped from India – the Cashmere goat, a silkworm and a bird.

While waiting for Sumner's company to acquire Cashmere goats, the ASV received several from Ledger. At an ASV Council meeting in December 1861 McCoy heard Ledger's promise to send several Cashmere goats he had offered the Zoological Committee (and his request for the balance of the government's £2000 for alpaca importation), and in February 1862 that three goats had arrived. Later, when Ledger's alpaca activities attracted stinging suspicion, McCoy prepared explanatory resolutions and joined deputations aimed at extricating the ASV from their dealings with Ledger without losing the whole £2000.

ASV Council minutes reveal the involvement of a Calcutta company - Messrs Gillanders, Arbuthnot & Co (which began seeking Cashmere goats for the Zoological Committee in 1861) – and that, after hearing in March 1862 Sumner's company's question about advertising in Calcutta newspapers, McCoy re-initiated action. On 3 June he successfully moved

That Mr. Sumner be requested to purchase through his firm in India pure Cashmere shawl goats to the extent of the £200 now in his hands and that application be made to the Government for a run on a Gipps Land mountain with a sufficiently low temperature to favor the best development of the fleece of Llamas, Alpacas and Cashmere goats.

While the Calcutta company remained willing to procure Cashmere goats for the ASV, the Victorian government claimed that it had no suitable unoccupied land for them and suggested Angus McMillan in Gippsland. In October 1862 McCoy attended ASV Council meetings which decided that the goats should be sent to Gippsland and heard from the Calcutta company that C.B. Chalmers was collecting Cashmere goats for introduction into Australia. In his ASV annual address in November McCoy was pleased to report that

in a few months we expect a large number of the pure Cashmere-shawl goat, from Thibet, which have been already purchased for the Society, with the intention of forming a great herd on some of the highest mountains of Gipps Land, which retain snow sufficiently long to produce the temperature necessary for preservation of the finest qualities of the wool and hair' (ASV 1862: 50).

ASV Council minutes and annual report in 1863 chart Cashmere goat movements. Chalmers brought half the flock to Melbourne, leaving the other half sweltering in Calcutta until the next mail steamer left. At Royal Park on 21 April the ASV Council thanked Dr Chalmers profusely for his 'invaluable services in procuring the Cashmere goats for the Society' and inspected them. McCoy attended the next meeting which decided to ask William Degraves if the goats could stay on his station at Omeo. On 5 May McCoy reported a goat death and heard that Degraves would accept the goats provided 'the Society paid all expenses and gave him a fair proportion of the increase'. His offer was declined. W.G. McCullough of Maryborough had earlier offered to take the goats, and Sumner suggested that, provided he paid all expenses, he should be allowed to take them, thus freeing the Society's funds for other purposes. On 12 May McCoy heard that the second lot of Cashmere goats (21 goats and two kids) had been shipped from Calcutta; and on 16 June that 17 goats and four kids had reached Melbourne. They were extremely weak and ill. The ASV annual report recorded the purchase of 49 valuable-fleeced Cashmere goats which

Chalmers had collected (and, like Ledger, smuggled out) and transported thousands of miles in nine exhausting months to Calcutta. Many, including the whole second consignment, died, leaving only 25 at Royal Park late in 1863 (ASV 1863).

ASV Council minutes record goat illness and recovery, births and deaths. McCoy examined them. In July 1863 he attributed several deaths to 'excessive debility caused by skin disease' and recommended treatment 'as for the scab' (which was ravaging Victorian sheep flocks). On hearing that McCullough would take the goats provided he receive half of any increase, the ASV Council decided on 17 November 1863 to send them to him. At the next meeting McCoy heard that they had reached Maryborough safely. McCullough kept the ASV informed of flock increases. At a Council meeting in May 1864 McCoy heard of four recent births, and in December that the flock had grown to 30. They were reputedly thriving at Maryborough (ASV 1864).

But all was not well. In May 1865 McCullough wrote offering his portion of the flock at cost price. However the ASV Council 'did not feel disposed at present to expend any further money on Cashmere goats'. In July McCullough returned the goats to Melbourne. They were in very poor condition and several were Angora-Cashmere crosses. In his accompanying letter McCullough regretted some accidental cross-breeding. In December 1865, 27 Cashmere goats were recorded as Royal Park residents (ASV 1866).

Another desired textile was silk, and in the 1860s there were great hopes for sericulture in Victoria. McCoy was interested in an Indian silkworm. In his ASV annual address he explained that Arrindy silkworms produced cocoons of strong, coarse silk from leaves of the castor oil plant, which were less sensitive to hot winds than those of the mulberry tree which fed another silkworm. Fortunately the castor oil plant grew 'here most luxuriantly as a perfect weed' (ASV 1862: 44).

On receipt of Arrindy silkworm eggs that had become dehydrated and died during the long voyage from Calcutta, McCoy prepared 'a memorandum of instructions' for forwarding to India, and expected 'by trying the eggs, the larvae, and the pupae, to succeed in establishing the species before the next anniversary' (ASV 1862: 44). This was not to be. On 16 June 1863 McCoy reported receiving a case of dead castor oil plants with dead silkworms, and at the next meeting he handed another memo on their care and transport to be sent to Calcutta. The ASV Council mentioned these failures in its second annual report (ASV 1863), and another in its fourth annual report, which noted that McCoy had 'always been most anxious to secure the introduction of this silkworm' and had again prepared instructions for despatch to India (ASV 1866: 7).

McCoy's persistent efforts were unsuccessful, but at the annual meeting in 1871 the ASV Council thanked him for his 'great interest always shown in developing sericulture' (ASV 1871: 7). In its next annual report the ASV Council admitted the difficulty of advancing sericulture in Victoria, but remained hopeful that when white mulberry trees (widely distributed by Mueller) matured sericulture could support a viable industry (ZASV 1872).

Meanwhile there was the 'vexed question of the sparrow and minah' (ZASV 1872: 8), which had been introduced to destroy insect pests. Sparrows arrived before the birth of the ASV. Mueller (1861) recorded some in the Botanic Gardens, and ASV Council minutes and annual reports record the 1863 arrival of English, Chinese, Java and Indian sparrows, and their liberation in the Botanic Gardens, Royal Park and elsewhere.

Indian minahs (now known as Common Mynas), or mino birds as they were sometimes called, were welcomed as valuable insectivorous birds. Along with a couple of sparrows and the second lot of Cashmere goats, seven mino birds arrived from Calcutta in June 1863. They were not the first. The previous November Landells' shipment reached Melbourne. At the ASV Council meeting on 9 December 1862 McCoy heard discussion of the purchase of Landells' mino birds for the substantial sum of 20/- per head, and their despatch to the Botanic Gardens, the University and elsewhere. Mueller received 28 and McCoy six. Unable to attend the next meeting, McCoy wrote that 'the Minos liberated at the University had distinguished themselves as indefatigable grub and grasshopper destroyers'. They flourished in the Botanic Gardens' crowded aviary, and the following spring 50 were liberated in the Gardens (ASV 1863), where they were soon nesting in the hollows of old trees.

By 1864 the ASV had an aviary at Royal Park. At ASV Council meetings in January and February 1864, McCoy heard that, after a short stay in the aviary, 20 mino birds were liberated in Royal Park by no lesser person than the president. Later the Council reported that insect-destroying birds, including sparrows and 'a most active and interesting bird, the Indian mino, may now be considered thoroughly established, and are rapidly extending by natural means through the Colony' (ASV 1864: 33).

Indigenous and introduced birds and animals could then gain legislative protection under Victoria's game act, and the ASV was careful to have precious introduced ones, like sparrows and minahs, listed under that act. However not all Victorians were adequately impressed with their pest-destroying capacities. Complaints against their fruit-eating propensities were voiced at the ASV's annual meeting in 1868 (Balmford 1981). The meeting's report in Melbourne's *Argus* of 13 March 1868 noted that

> Professor McCoy maintained that the sparrows fed their young entirely on grubs; that the damage done to the fruit was mainly the work of native birds; and that any little fruit or grain which the sparrows might eat was insignificant compared with the service they performed in taking away the grubs.

ASV Council meetings during 1870-71, rarely attended by McCoy, considered the removal of sparrows and minahs from the protection of the game act, so that the public could legally destroy them. The ASV annual meeting in March 1871 included some discussion of sparrows, which was reported in the *Argus* and *The Australasian* (ASV 1871). The following week 'The Naturalist' column in *The Australasian* of 25 March was 'Our Acclimatised Sparrows and Minahs'. After discussing the great insect-devouring capacity of sparrows, McCoy, alias Microzoon (Whitley 1969), claimed that minahs were

> of incalculable value for checking the increase of insects which are either too large or cannot be reached by the sparrows, such as the immense variety of locusts and grasshoppers, which so swarm in some years as to destroy every green thing where they come. The insects which spend the early stages in the earth, eating the roots of the grass, &c., as the larvae of many beetles, moths, field crickets, &c. do, are destroyed in great numbers in this stage by them, and in the Royal Park and University grounds the minahs may be seen walking over the grass in regular lines digging them out all day like rooks, and when the perfect winged creatures appear, they are chased and killed by the same bird with incessant energy.

ASV opinion was less wholeheartedly supportive. Council Minutes for 19 May 1871 noted that while

> Sparrows and Minahs are extremely valuable and do great good by destroying noxious insects which otherwise would do much more injury to the fruit and grain than the birds, yet still in deference to the opinions of other public bodies the Council will not oppose [their] removal ... from the Game Act.

The ASV's annual report for 1871 noted their removal, and that 'Melbourne, from its size and importance, ought to number among its attractions a good zoological collection' (ZASV 1872: 6).

The Zoological and Acclimatisation Society of Victoria -lions and a zoo

In 1872 the Society became the Zoological and Acclimatisation Society, and *in absentia* Professor McCoy was re-elected a vice-president (ZASV 1872) for the last time. McCoy's acclimatisation decade was ending. Sadly the ASV had not provided faunal foundations for a silk or cashmere-wool industry, and the insect-devouring capacity of sparrows and minahs had not satisfied fruitgrowers. With its name change the Society shifted its focus from acclimatisation to zoological display, and its menagerie at Royal Park changed dramatically. Now there were lions but no alpacas or Cashmere goats. The 'most notable additions' in 1872 were 'a fine pair of African lions, a leopard, a black bear from California, and some Indian monkeys' (ZASV 1873: 7). Not one was a useful ruminant! The Zoological and Acclimatisation Society was now developing the sort of zoo preferred by a public who wanted to see more interesting animals than useful ones awaiting homes elsewhere.

Acknowledgement
Doug McCann provided Microzoon's 1871 article and evidence that McCoy was the author.

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'Sir Frederick McCoy was buried in the Brighton Cemetery, Melbourne, on May 16, 1899. As an indication of the regard in which this famous scientist is still held among natural history authorities in Victoria, the Field Naturalists Club of Victoria has undertaken, as part of its normal functions, the maintenance and care of his grave.

'The name of Sir Frederick McCoy has been commemorated in scientific circles in the McCoy Society for Field Investigation and Research, which came into existence in August 1935, a society which set out to study in a detailed manner the ecology of definite Australian environments, particularly those of the islands along the southern coastline.'

Extract from page 87,
Collections of a Century:
The History of the First Hundred Years of the National Museum of Victoria,
by R.T.M. Pescott
(National Museum of Victoria: 1954).

McCoy's grave. Recently photographed by Doug McCann.

The Fate of the Cranbourne Meteorites

Sara Maroske[1]

An unknown number of years ago, a meteorite crashed to earth at what is now called Cranbourne, an eastern suburb of Melbourne. The extra-terrestrial origin of this meteorite's fragments was recognized in 1860, at which time they also became scientific curiosities considered worthy of institutional acquisition. Two men in particular vied for the right to collect them. Frederick McCoy wanted the best fragments for the recently formed National Museum of Victoria in Melbourne (hereafter Melbourne Museum), and Ferdinand Mueller (later Baron von Mueller), Government Botanist of Victoria and Director of the Melbourne Botanic Garden, thought they should go to the British Museum in London. The ensuing argument between these men involved a local and international cast of players, and their differing views of science, patriotism, and even the value of friendship itself.

Iron outcrops were known to European settlers at Cranbourne since the 1850s, but they were assumed to be of terrestrial origin. In 1860, however, Edmund FitzGibbon, the Town Clerk of Melbourne, visited the area to assess its suitability as a destination for a railway line (Walcott 1915). FitzGibbon was also something of a naturalist and he took the opportunity to examine the iron deposits. From their 'general resemblance to aerolites known to have fallen in other parts of the world', he deduced that they were the remnants of a meteorite (*Transactions of the Royal Society of Victoria* 1860). On 4 June 1860, he exhibited two specimens at a meeting of the Royal Society of Victoria, the premier local gathering of scientists, where they stirred up great interest in the members, including McCoy and Mueller.

In February 1861, a scientific expedition went to Cranbourne led by Georg Neumayer, Director of the Flagstaff Observatory and instigator of a magnetic survey of Victoria. The expedition identified a number of meteorite fragments embedded in the ground, including two large ones. The smaller of these large fragments weighed about 1.5 tonnes, and was bought from the owner of the land on which it was found by another expedition member, Augustus Abel (a German mineralogist who had settled in Ballarat). It became known as the Abel Meteorite. The larger fragment, which weighed 3.5 tonnes, was acquired by a neighbouring landowner, James Bruce (a British immigrant). It became known as the Bruce Meteorite. At the time of its discovery, this meteorite was thought to be the largest in the world (Walcott 1915; McMullen 1998; Lucas *et al.* 1994).

Neither Abel nor Bruce wanted to keep the meteorites for themselves. Abel was a mineral dealer who recognized his meteorite's value to collectors. He intended to exhibit it locally in Melbourne, then at the London International Exhibition of 1862, and offer it for sale at £300. Bruce was also happy to move his meteorite out of Australia, and decided to present it to the British Museum in London where he had 'spent many a pleasant day' in the past, 'and gained some information.' (Bruce 1862a). He apparently refused all requests to sell his meteorite, arguing that, because it was only of interest to scientists, it would be wrong to treat it as a piece of merchandise (Lucas *et al.* 1994).

The British Museum was actively involved in collecting meteorites in the 1860s, and was delighted at the prospect of acquiring the Bruce specimen by donation. It was also not averse to purchasing the Abel specimen. The Museum set about obtaining both meteorites with the assistance of Mueller. It is not absolutely clear how Mueller came to be the Museum's Melbourne agent, but he was in friendly communication with the Museum's Keeper of Mineralogy, Nevil Maskelyne (later Story-Maskelyne), as well as with Bruce and Abel, from the time that knowledge of

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the meteorites was first made public. Mueller was also on record for thinking that the specimens belonged in the British Museum, where they would be 'higher appreciated than elsewhere.' (Lucas *et al.* 1994; Mueller 1862a *unpubl.*)

The burgeoning city of Melbourne had established a natural history museum in 1854, with McCoy as Director from 1856. McCoy was aware of the interest by the British Museum in the Cranbourne meteorites and, while respecting the imperial institution's prestige, and also being in friendly communication with some of its staff, he believed that the meteorites were better placed in Melbourne. He tried to get Abel to reduce the price of his meteorite to an amount that the Melbourne Museum could afford, but was unsuccessful. He also tried to persuade Bruce to donate his meteorite to the Melbourne Museum where he argued that it would be 'of much greater interest' than at the British Museum 'from local associations' (McCoy 1862a *unpubl.*).

Bruce, Mueller and McCoy all spoke of 'interest' in the meteorites when discussing their disposal. They agreed that this 'interest' was scientific but disagreed about where it was likely to be best developed. McCoy argued that Melbourne scientists were not only well-capable of analysing the meteorites, but likely to do so with enthusiasm because of the local rarity of such objects. Mueller argued that at the British Museum they would be accessible to more scientists than in Melbourne, and therefore subject to the most capable and numerous analyses. Bruce was persuaded by both men and ended up offering McCoy half his specimen, provided the British Museum would agree to the cost of its division, and the Melbourne Museum to the cost of its transport (Lucas *et al.* 1994).

While waiting for McCoy's response to this offer, Bruce was contacted by Mueller, who asked to be given possession of the Bruce Meteorite on behalf of the British Museum. Bruce wrote to McCoy saying that he intended to accede to Mueller's request, because he assumed that 'as both Dr Mueller & yourself were members of the Royal Society [you] had mutually agreed as to the steps that each was taking in the matter.' (Bruce 1862b *unpubl.*). In this, Bruce was mistaken. Mueller and McCoy were certainly well-known to each other, and had co-operated in the exchange of natural history specimens, and in local scientific matters, without rancour, in the past (Home *et al.* 1998), but this time they had opposing views. Thus, Mueller appears to have contacted Bruce without knowing about his offer to split the meteorite.

When McCoy learned of Bruce's decision, he rallied the support of a number of local scientists and pressured Mueller to accept a division of the meteorite. Mueller felt himself torn between a desire to keep his undertaking with the British Museum to acquire the whole meteorite for its collections, and to maintain civil relations with the other members of the small community of Melbourne scientists. He believed that he was being asked to compromise his pure scientific principles by petty colonial interests, but he gave way nonetheless. In his letter of submission, he told McCoy that 'we are doing a deplorable act in cutting such a rare cabinet piece, especially as it then no longer will anywhere predominate over any other Meteors' (Mueller 1862b *unpubl.*).

On the eve of a successful (if not mutually satisfactory) resolution to the negotiations, another suggestion apparently occurred to McCoy, which he communicated to Mueller. 'As for our rival claims on the meteorite,' he declared, 'I would suggest the good old test of single combat and walking on red-hot plough shares to see with whom the right lies — unless indeed the British Museum would [solve] it by sending us Abel's own.' (McCoy 1862b *unpubl.*). McCoy seemed to be saying that he would accept a swap of the Abel for the Bruce Meteorite. This would not give the Melbourne Museum the larger meteorite, but it would give it a complete one. It would also let Mueller satisfy his obligations to the British Museum, and Mueller lost no time writing to London for agreement to the proposal.

Newspaper reports in Melbourne of the dispute between the two museums roused community interest in the fate of the meteorites. In July 1862, John O'Shanassy, the Chief Secretary (and head of the Victorian Legislative Assembly), set up a committee of inquiry to determine what, if any, action the Government should take in the matter.

The Committee was chaired by George Evans (a member of parliament) and consisted of McCoy, A.R.C. Selwyn (Director of the Geological Survey of Victoria) and R. Brough Smyth (Secretary of Mines). Mueller could hardly have been pleased with this development. All but the committee chairman were on record as supporting the view that the Bruce meteorite should not leave the colony (Lucas *et al.* 1994).

In September 1862, letters from London agreeing to the swap of meteorites were read at a meeting of the Royal Society of Victoria. Maskelyne added that the British Museum was also prepared to send the Melbourne Museum some fossil casts and duplicate specimens. He was presumably unaware that the Melbournians would take offence at his view that the swap was only assigning to the imperial and colonial museums 'their proper relative functions of mutual interest and support.' The Royal Society of Victoria scientists did not appreciate being seen as inferiors. After some discussion, they gave notice of a motion that the Melbourne Museum should keep both meteorites, and send only casts and specimens to London (*Transactions and Proceedings of the Royal Society of Victoria* 1865).

McCoy sought to garner further support for his museum's claim through the Committee of Inquiry. In 1863, after the chairman returned from a long absence from the colony, a series of committee meetings was held, and a draft report delivered to the Chief Secretary. It concluded that the Melbourne Museum had a 'right' to half the Bruce Meteorite, and the British Museum a 'right' to the other half. If, however, the British Museum had already bought the Abel Meteorite in order to swap it for the Bruce Meteorite, then the Committee recommended that the British Museum Trustees should be reimbursed the purchase price of the Abel Meteorite, and allowed to retain it for their collections 'on condition of their relinquishing all claims to the larger meteorite.' (Evans *et al.* 1863 *unpubl.*)

Mueller did not appear before any of the Committee's meetings. He waited to be called, only to discover, when it was too late for him to do anything about it, that the Committee expected him to apply to present evidence. In his absence, the Committee was free to impugn his actions and to assign their own motives to them. Its report to the Government expressed 'strong disapprobation' of 'those gentlemen who have in any way been instrumental in urging Mr Bruce to accede to the removal of the Meteorite' (a thinly veiled reference to Mueller). It also observed that Bruce had sought to be guided by the advice of 'Scientific men', and that it regretted that the advice he had received 'was not dictated by more patriotic moves.' (Evans *et al.* 1863 *unpubl.*)

In September 1863, Mueller and McCoy met at Mueller's house at the Botanic Garden and argued about the meteorites. McCoy apparently left 'in such emotion' as to prevent Mueller 'from apologising for the offence I have unconsciously given you.' Mueller tried to salvage his friendship with McCoy by offering to give up representing the interests of the British Museum (Mueller 1863a *unpubl.*). Mueller also wrote to the chairman of the now-defunct Committee of Inquiry and to Maskelyne at the British Museum in the same vein. As a public servant in the colony of Victoria, he explained that if his government chiefs disapproved of an exchange of meteorites then he would have to act in accordance with their wishes (Mueller 1863b, c *unpubl.*)

In the nineteenth century, the idea that unique natural history objects properly belong in their country of origin was novel. The primacy of imperial institutions was assumed by many colonists as well as by these institutions themselves. In making a claim for the Bruce Meteorite, the Melbourne Museum was acting out of the ordinary. Maskelyne was so irate when he learned of Mueller's treatment in Victoria that he was only just restrained, by Mueller (for the sake of the honour of the scientists of Victoria), from laying the matter before the Royal Society of London. He regarded McCoy as guilty of a 'disgraceful breach of faith', while Mueller had 'maintained an attitude such as a German or an English gentleman must always wish to maintain, an attitude of honour and truthfulness' (Maskelyne 1864 *unpubl.*).

What was the Government of Victoria to do? James McCulloch (O'Shanassy's successor as Chief Secretary of Victoria in 1863) was faced with a difficult decision. He was aware that local patriots wanted the meteorites to stay in the colony, but his government was not sufficiently independent of imperial influence to disregard it entirely. McCulloch read the Committee of Inquiry's report and invited Mueller to a discussion of the other side of the argument. Mueller suggested that McCoy had failed to 'show cause why the pledge made by himself should not be redeemed' (i.e. a swap of the Abel for the Bruce Meteorite) (Mueller 1864 *unpubl.*). McCulloch agreed, and determined that the Bruce meteorite could 'be only treated as the property of the British museum' (McCulloch 1864 *unpubl.*). This decision was duly transmitted to the British Museum trustees (Lucas *et al.* 1994).

Meanwhile, McCoy was actually in possession of both meteorites. The Bruce Meteorite had been stored at the Melbourne Museum pending a decision as to its disposal, and the Abel Meteorite arrived there in late 1863. It had been addressed in London to the 'Melbourne Museum care of the Governor of Victoria', but had been delivered directly to McCoy, who did not admit to having it until pressed by the Governor. The Bruce Meteorite was removed from the Melbourne Museum in January 1865 for shipment to London. To the last, McCoy tried to stop its removal, writing letters to various government officials, but to no avail. The Bruce Meteorite was installed in the British Museum in November, minus only a thin slice which was sent back to the Melbourne Museum (Lucas *et al.* 1994).

The definitions of science, patriotism and friendship were all tested in the argument surrounding the disposal of the Cranbourne meteorites. The Melbourne and London museum directors both thought that possessing the meteorites was necessary for their proper analysis, but in the end neither institution published much about them (Lucas *et al.* 1994). The definition of patriotism was also transformed by the dispute in such a way as to admit of loyalty to colonial as well as imperial institutions. In this regard, McCoy was one of the first of many scientists who have fought for Australian ownership of significant local specimens. As to McCoy's friendship with Mueller, while it was damaged by their disagreement about the meteorites, civility, at least, between the two men was soon restored, and they continued to have a productive working relationship for the rest of their lives.

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Frederick McCoy and the Naturalist Tradition

Doug McCann[1]

Abstract

From August 1869 until May 1871, an anonymous naturalist under the pseudonym 'Microzoon' published a superb series of articles in a weekly Melbourne newspaper, *The Australasian*. The author was undoubtedly Frederick McCoy. The Microzoon articles provide a valuable early record of aspects of the natural history of Victoria, in particular the bird life, but also covering a selection of other topics including snakes, insects, fish, molluscs, geology, palaeontology and stratigraphy. (*The Victorian Naturalist* **118** (6), 2001, 309-313.)

Introduction

Frederick McCoy was one of Australia's first professional scientists. His career began in Ireland in the late 1830s a time when natural history had gained immense public popularity and amateurs carried out a great deal of early geological, botanical and zoological work. These amateur naturalists comprised people from all walks of life but were usually from the middle and upper classes including a dedicated elite of so-called 'gentleman naturalists'. As the industrial revolution progressed, a new scientific and technological community emerged and established science as a profession in its own right. By the 1850s, this newer, younger and more numerous body of professionals were challenging and replacing the older gentlemen naturalists. Many of the older elite still held senior positions in the universities, and in amateur and professional societies, but a generational change was taking place. This succession was accompanied by a change in philosophical outlook or 'world-view' as well.

McCoy is an interesting individual for historical study because his career spans what could be called a 'paradigm shift' from amateur science to professional science, from Natural Theology to 'Naturalism' and Darwinism, and from an organic world-view to a more empiricist, mechanistic and materialistic world-view. In many ways McCoy remained true to his earlier formative influences. Henry Woodward observed, on McCoy's death in 1899, that McCoy really belonged 'to the first half of the present century, but who has survived almost to its close' (Woodward, 1899: 283). Woodward's observation is germane. True to the earlier naturalist tradition, McCoy remained an amateur in spirit even though he became a professional at a very young age.

The beginning of McCoy's career in the late 1830s represents a peak time for great collectors and great collections. When McCoy arrived in the Colony of Victoria in 1854 and subsequently established himself as Director of the National Museum of Victoria he finally had a chance to make his mark as a great collector in his own right. He spent the rest of his long career developing what became one of the great colonial museums. As a museum director and systematic taxonomist he relied upon a network of professional and amateur collectors and always remained supportive and sympathetic towards the amateur naturalist. When the Field Naturalists Club of Victoria was established in 1880, McCoy became the first President. Even though he did not attend regular meetings (see Houghton, *this issue*), McCoy was keen to encourage people of all persuasions to participate in the collection of natural objects and organisms, especially new and exotic ones, and in the study and documentation of the natural environment.

Microzoon

In the late 1860s a natural history column appeared in a weekly Melbourne newspaper, *The Australasian*, under the banner 'The Naturalist'. The author was anonymous and published under the pseudonym 'Microzoon'. It appears that it was never officially made public just who the unknown writer was, but almost a century later the naturalist D.J. Dickison speculated in the *Australian Bird Watcher* that it was probably Frederick McCoy. Dickison wrote:

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> The name and the author of the articles which ran through *The Australasian* for several years, and dealt with all branches of the natural history of Victoria, has never been disclosed. However, there is strong evidence to suggest that the writer was Professor Frederick McCoy, who was the Director of the National Museum at that time, as there is a reference in one of the old letterbooks at the museum of a proposal made by McCoy to the Editor of *The Australasian*, that he be given permission to contribute articles, at intervals, on the subjects of interest in the National Museum. It was also apparent that the articles had been written by a naturalist of some ability and who had a good general knowledge of the fauna of Victoria (Dickison, 1960: 77-78).

Dickison's claim may have gone largely unnoticed had it not been for the interest shown in the Microzoon column by the eminent naturalist Gilbert Whitley, formerly an ichthyologist at the Australian Museum. For years Whitley had wondered who Microzoon was; he had suspected that it might have been the accomplished naturalist Gerard Krefft who had lived and worked in Victoria and later became Director of the Australian Museum in Sydney, or some other competent natural history writer. After extensive inquiries Whitley became convinced that it was Frederick McCoy who was the anonymous author. In an article entitled 'Who was "Microzoon"?' in the *Australian Zoologist* in 1969 he briefly related that he thought that 'Dickison's theory was right' and published a list of all the Microzoon articles he could find in *The Australasian*. There was a total of fifty articles in all and they ran from August 1869 to May 1871.

There is no doubt that the author of the Microzoon column was indeed Frederick McCoy as Dickison and Whitley have surmised (Branagan 1998). Whitley is accurate when he states that:

> From internal evidence in the articles themselves, he was obviously a member of the Acclimatisation Society in Melbourne, on the staff of or closely connected to the National Museum, and not a young man (Whitley 1969: 121).

As Dickison observed it is obvious that Microzoon was an exceptionally competent and well-informed naturalist. He makes numerous references to the collections in the National Museum and had intimate knowledge of their content and organization. He also makes a number of allusions to the University of Melbourne where McCoy was professor of Natural Science, and to the suburb of Brighton and Brighton beach where his later home was located. In one Microzoon article (21 August 1869) the writer mentions that he was in London some twenty years previously, as was McCoy. In most of the articles the text is almost identical in style, tone and content to McCoy's writings in his official publication such as his *Prodromus of the Palaeontology of Victoria* and his *Prodromus of the Zoology of Victoria* (McCoy 1874-1982;1878-90). No other naturalist in the Colony of Victoria but McCoy would have had the detailed palaeontological, geological and zoological knowledge displayed in the Microzoon articles.

The column was one of the first natural history columns in Australia. It is a valuable early record of some aspects of the natural history of the Colony of Victoria. The articles were 'refreshingly Australian, a pioneer ornithology of Victoria, and included here and there some rare or novel species of bird or reptile' (Whitley 1969: 121). The content of the Microzoon articles is at times quite specialized and technical, mentioning such things as the appearance, dimensions, habits, location, behaviour and ecology of various natural history organisms and objects. They are also written in a relaxed and entertaining style, and are interesting and sometimes humorous. A wide range of topics are covered but there is a concentration on a detailed and systematic survey of the birds of Victoria; in fact, birds are the subject of half of the articles, making the column a valuable historical resource on Victorian ornithology. Similarly, there is a series of five articles on snakes. A random selection of other topics is covered, including fish, insects, molluscs, turtles, the Tasmanian devil, pearls and diamonds.

Of particular interest is a series of articles entitled 'Why is Australia odd?' in which the author explains how local work in Victoria by 'the Melbourne palaeontologists' (meaning McCoy and his staff) disproved the popularly held notion that Australia was qualitatively different, both geologically and biologically, from the northern hemisphere, and instead confirmed that geological processes were universal and that the geological column was global. Further, the writer contended that these discoveries were fatal to the theory of 'progressive development' and the idea that evolution occurred at varying rates in different regions around the globe. According to the author those who hold such views are 'the suicidal betrayers of their own ignorance'. Instead, he suggests, the evidence does not contradict the more traditional notion of successive progressive 'creations'.

Another series of four Microzoon articles has the heading 'Geological walks and talks at large' and is a succinct and edifying introduction to field geology, including how to determine the of angle of 'dip' and the 'line of strike' of rock strata, instructions for collecting rocks in the field, and how to construct a makeshift clinometer. The author emphases the importance of fossils, stating that:

> The greatest characteristic of modern geology is the entire abandonment of the lithological character or nature of the stone as a means of identifying the various geological formations, and the firm reliance on palaeontology, or the study of fossils, alone as a sure guide (Microzoon, 25 February 1871).

The author then figuratively takes the reader for a walk from the Post Office in Elizabeth Street starting 'upon one of the most famous of all geological formations the Silurian' the beds of which are 'sharply contorted and dipping in various directions' and walking north to Royal Park where 'in the bed of Mooney Ponds (sic) creek, and in the little cliffs on each side of it, you can learn as good a lesson on the subject as if you were in Wales' (Microzoon, 13 May 1871). The Silurian rocks held a special interest for McCoy because he had been involved in a famous debate between Adam Sedgwick and Roderick Murchison as to their structure, composition and extent (see McCann, this issue).

In the Microzoon articles there are several references to the Acclimatisation Society. The author is passionate in his defence of the principle of introducing exotic species of plants and animals and stern in his remarks against those who criticize the practice. He deplores the 'ignorant popular clamour' of those who now claim that introduced species like the sparrow are causing more harm than good:

> These birds, especially the sparrow, have multiplied greatly, and now the same outcry has arisen here as has arisen from the more ignorant of the farmers and gardeners in various parts of Europe, and in the various States of America, against useful small birds, namely, that they have been occasionally seen to eat fruit and grain in their season (Microzoon, 25 March 1871).

He argues that the sparrows consume 'enormous quantities' of harmful pest species of insects and insect larvae all year round and that the benefits greatly outweigh any relatively minor problems such as the consumption of some small part of ripened crops. As for the Indian minahs (now known as Common Mynas) the author points out that 'they are of incalculable value for checking the increase of insects' and that the value of their services are 'well known in India, and the French in New Caledonia are so eaten up by these insects, that they have asked the Acclimatisation Society of Melbourne to aid them in introducing their only help the minah'.

One of the pleasures of perusing the column is reading the various anecdotes and poetic descriptions of the natural history of the colony. The writer employs phrases like 'this most beautiful species' (referring to Jardine's Harrier, now commonly known as the Spotted Harrier) or 'this is an amusingly pugnacious little species' (referring to the Little Whip Snake). Often he is philosophical: 'there is rarely any waste in nature', or historical: 'Even so far back as the time of Aristotle the European bird of this kind (i.e., the goatsucker) is referred to in his *History of Animals*...', or humorous: '...they are 'varra interesting' as a wise man I knew once used to say of anything he could not comprehend'. Glimpses of the interactions between the colonists and wildlife can be gleaned from the column; for example, the tiger snake is reported to be 'very common along the margins of the Yarra, especially in the Governor's grounds at Toorak, and very common in all the swampy ground near Sandridge, St.

Kilda, and other places around the city.' (Microzoon, 1 January 1870). The column is also valuable because it allows comparisons to be made between the environment and fauna of the period, particularly in the Melbourne area, and subsequent changes – for instance, the disappearance of both reedbeds and Reed Warblers from the banks of the Yarra near Princes Bridge (Microzoon, 11 February 1871), and the loss of the heathlands in the Brighton area along with their honeyeaters (Microzoon, 7 May 1870).

Occasionally the writer, when emphasizing some particular aspect of the local natural history, mentions prominent citizens of the Colony, for example, when discussing the Grey Falcon, he notes:

> A specimen of this excessively rare species flew into Captain Clarke's kitchen, at Merri Creek, after a chicken, which it carried off. It was shot, and is now in the National Museum (Microzoon, 25 September 1869).

Likewise, when discussing the Australian Goshawk:

> This fine species is rather scarce about Melbourne, but one in the National Museum was shot at Flemington by Mr. Brough Smythe, and a few others have occurred in other spots in the colony, and it is known from Tasmania to Moreton Bay (Microzoon, 6 November 1869).

Some other local identities mentioned include Professor Halford (and his experiments on curing snake bite by the injection of ammonia), naturalist Gerard Krefft, and editor of the *Argus* and founder of the Acclimatisation Society, Edward Wilson. The author even refers to himself (in the third person – as 'Professor M'Coy').

The writer's humour is evident in his discussion on the Murray Turtle *Chelymys macquaria*. Apparently the colonists did not view this turtle as a particularly attractive object for food consumption:

> … The present species is the commonest *Cheloniax* in the Murray River, and is occasionally sent down as a curiosity to the fish-markets, with the so-called Murray cod and other fish, but it has not come into use at all for the table, notwithstanding the suggestions of the Acclimatisation Society.
>
> Mr Kinglake is often doubted by readers of his famous assertion that the present Emperor of the French turned green on a certain occasion from emotion, but I have seen the name of this creature produce exactly the same effect on a great literary luminary formerly residing in Melbourne, to whom I mentioned it in confidence at a dinner of the Acclimatisation Society, after he had incautiously swallowed a good plateful of what was called "turtle soup" on that occasion, but which I know was made of the vile anatomy of this *Chelymys*, deceitfully disguised by a skilful cook (Microzoon, 30 April 1870).

Another example of his sometimes tongue-in-cheek style is evident in his discussion of the Cicadae:

> … This insect is a *Cicada*, nearly alike in structure, general appearance and habits, to the famous *Cicadae* of the old classic writers of Greece and Rome, who seem to have had as queer a taste in music as the modern Chinese, who, like the ancient Greeks, are said to keep these insects in cages for their song… As only the males can sing, the ancient poets attributed their loud jollity to the happiness arising from the knowledge that their wives were mute – but this is now known to be mere slander. That Tithonus, the consort of Aurora, was changed in his old age into a *Cicada*, although devoutly held by the ancients, is also now generally disbelieved by modern entomologists, who classify the *Cicada* amongst the true Hexapod insects in the modern order *Homoptera* (Microzoon, 29 January 1870).

A further example of his humour is in his discussion of the kookaburra where he refers to an account of a difficult journey by two early travellers from Western Australia, where the bird is not endemic, to the settlements of Southern Australia. The traveller's ended their narrative expressing their sense of comfort and enjoyment with which the evening passed, after due refreshment, 'listening to the laughing jackass'. The author of Microzoon noted: The German editor of a well-known geographical journal, translating this account, gives the epithet with inverted commas, and the remark in a foot-note that 'some political allusion is probably intended here, as we believe the quadruped has not been introduced into Australia.' (Microzoon, 9 April 1870).

The Microzoon series ends abruptly on 27 May 1871. The writer obviously intended to continue the series because at the end of the final article he promises to discuss the significance of asymmetrical folding of rocks such as is found in some synclines '... a fact of great importance as we shall see...'. It is not clear why the Microzoon series suddenly ended at this time; McCoy was still at the peak of his career. He went on to produce his greatest Australian publications, his *Prodromus of the Palaeontology of Victoria* (1874-82) and his *Prodromus of the Zoology of Victoria* (1878-1890). However, this was about the time that McCoy became embroiled in problems following the appointment of a Museum Board of Trustees. Whatever the reason he let the series lapse, we owe a debt to McCoy for the popular writing which he did do, and for providing us with a window into the natural history of the Colony at that particular time.

Conclusion

In 1880, a decade after the publication of the Microzoon articles, the Field Naturalists Club of Victoria was inaugurated and has continued ever since as a vehicle for studying and documenting the local natural history for amateurs and professionals alike. Considering his great pioneering contribution it was entirely appropriate that McCoy was chosen as the first President. His position was more of an honorary one than an active one; nevertheless he provided an important link between the professional work carried out at the National Museum and the more amateur work of the fledgling club.

In a more general sense McCoy represented a link between the older naturalist tradition and a newer, more impersonal, professional science. In addition, because of his considerable early experience in Ireland and England, he provided a link between a purely European view of nature and an indigenous Australian view. McCoy was moulded in the European institutions and practice but on arrival in Victoria he was confronted with a new environment. He was a major player in the attempt to Europeanise the new Colony especially through his work with the Acclimatisation Society. Nevertheless he played an important role in documenting and distinguishing characteristic similarities and differences in the natural environment between Europe and Victoria. He aided in dispelling some naive European views about the geology, palaeontology and biology of the Australian continent and helped place it in a global context. By building up large collections of the local natural history in the National Museum, and encouraging amateurs to study and collect it, he laid the foundations for further progress in understanding the indigenous natural history. It was left to others to carry that program forward from an Australian perspective, but it was McCoy who provided a bridge and a necessary first step.

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Frederick McCoy and the FNCV

Sheila Houghton[1]

Frederick McCoy was the first President of the Field Naturalists Club of Victoria, but, unlike Ferdinand von Mueller, he was not initially involved. His name does not appear in the list of members elected at the inaugural meeting in May 1880, but it heads the list following the record of the second meeting, and everyone has moved down one in the numbered sequence (FNCV Minutes 1880: 15 May 1880). The official members' register has him as number one, and it is clear from this that the position was an honorary one: McCoy did not pay a subscription (FNCV Members' Register 1880). In April 1883, at the meeting prior to the AGM, when a new President was to be elected, McCoy was elected an Honorary member, which maintained his connection with the Club, without any financial embarrassment. The invitation to McCoy to become the first President was a natural one. Not only did the fledgling Club require status, but as Professor of Natural Science at the University of Melbourne, McCoy was the obvious choice, and he was evidently ready enough to give his patronage to this new venture. Because patronage it was: in the three years of his Presidency he did not attend a single committee or ordinary monthly meeting, and played no part in the administration of the Club. His function, as he saw it, was to attend the Annual Conversazione, and deliver the Presidential address.

The Annual Conversazione was a big event in the life of the Club in the early years. It was held in the Royal Society's Hall, with a wide range of exhibits, and lectures were given, in addition to the address reviewing the year's work. (In 1896, for instance, when it was held in the Athenaeum Hall, it extended over two days.) In 1881 the Southern Science Record commented that 'it must have been a pleasing sight to the members, and especially to Professor McCoy, to see so large an audience assembled' (Anon 1881). The material for his addresses each year was supplied by the honorary secretary but something of McCoy's personality and attitude to the Club can be detected in them. His opening remarks in 1881 concentrate entirely on the 'glorious company' of honorary and corresponding members, each of whom he names, praising them for their 'enlightened zeal', 'extensive observations', activeness, or for possessing the finest collection in their particular branch of natural science. Turning to the activities of the Club he notes the papers given, mostly on botany and entomology, concluding that the evening meetings 'showed most pleasantly the advantage of men of scientific tastes and acquirements uniting together to describe the many new bearings of fresh observations'. Geology had not received its 'fair share of attention' and he proceeded to give a description of all the significant geological areas around Melbourne, comparing them to formations in England and Wales. There is a hint of astonishment in his resume of Club excursions. 'Who could have imagined that new fresh-water Polyzoa would be found in the lakes in the Botanic Gardens?' he asks. But he was glad to know that the excursions were conducted along the lines of those of the British Association, and that the 'social English recognition of the high part which the stomach plays' bringing all into 'friendly union' at the end of the day had not been neglected. His final remarks reflect the utilitarian approach to natural science, prevalent at the time, in that special attention should be given to injurious plants and insects, and he suggested that the Agricultural Association might assist the Club in these investigations (McCoy 1881).

In 1882 McCoy was unable to attend the Annual Conversazione, because he was suffering from bronchitis, which afflicted him increasingly in his later years. Rev. J.J. Halley read the speech in his absence.

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The FNCV had every appearance of becoming an established institution, but the majority of its most active members were still amateurs, and there is a hint of condescension in McCoy's opening remarks that they were meeting again 'to celebrate our usual annual "commencement", as the University men say...' The 140 ordinary members included ' nearly all the best known Victorian lovers of Nature' and he acknowledged the value of 'out-of-door exercise ... its great healthy attraction and its peculiar usefulness'. He noted again that amongst the Honorary members were 'the most distinguished Naturalists in every department of Natural Science in this and the other Australian colonies.' There was no doubt that there was a place for the Club, since nothing could be more really useful to Science than genuine field observations, accurately recorded, and he suggested that the 'interchange of observations and experiences of the collectors' (which had been the motivation for the establishment of the Club in the first place) should be 'recorded in a kind of commonplace book', which would make a 'delightful volume which would be eagerly read both here and at home'. In due course the Club produced *The Victorian Naturalist*. He praised the Club's plans to offer prizes to State school children for collections, with accompanying papers, at the next Annual Conversazione, and compared this to the practice of Professor Henslow ('my old friend') in his parish in Suffolk, England, who had observed the influence for good of such occupations on character and habits of later life, on the children of both sexes. McCoy's address concluded with practical instruction on how specimens should be recorded, especially if the name was not known (a numbering system), and suggestions of areas of study (McCoy 1882).

By 1883, in his third address, McCoy was obviously fully convinced of the usefulness of the Club, and approved of the direction it was taking. He regretted that it had not been possible to give prizes to State school children, owing to lack of funds, but expressed the hope that the government might make a small grant for this purpose. Excursions were now being run under the leadership of a competent person, which gave 'definite character to the work of each excursion' and less time was wasted in 'desultory wanderings'! McCoy, of course, had no direct experience of Club excursions. He praised the practice of cooperation between the amateur making local observations and someone with expert knowledge of the subject, as typified by Dudley Best's work on Colonel T.B. Hutton's collection of beetles from the Dandenong area. The study of ants was 'essentially one for a field naturalists' club', and he considered A.J. Campbell's admirable paper on Victorian birds' eggs 'a perfect model of the sort of continued, careful observation and record of facts which would render this Club famous'. If the FNCV had not quite arrived, it was well on its way. Scientific acknowledgement had been given to the 'acute observer'. J.F. Bailey, who had followed up McCoy's observations on fossil ear-bones of whales from the Waurn Ponds Miocene tertiary quarries by discovering similar remains near Cheltenham, recognised a new species which McCoy had named *Cetotolithes baileyi* in his honour (but unfortunately had been unable to illustrate or describe it because the Mines Department had ceased publication of the *Palaeontological Decades*). Henry Watts had collected and mounted many *Anoplura* (sucking lice) of Victorian birds, which were now in the National Museum. McCoy's attitude here was very much, 'keep up the good work', and he put forward suggestions for further study: fungi, to be sketched and coloured in the field, being a 'subject ... of great interest as not to be ascertained in the closet'; spiders; the teeth on the tongue of each species of the Gastropoda (suggested the previous year, but not followed up); insect larvae; living Polyzoa, Victoria being particularly rich in 'these beautiful little objects'; Hydroida; mosquitoes (those in Tasmania had been well described); and ants and gadflies. He concluded with a comment characteristic of his time, that all these subjects would provide valuable information which would be welcomed 'at home' (McCoy 1883).

McCoy's term of office came to an end in 1883, and Dr F.S. Dobson, M.L.A. was elected in June. He chaired the next committee meeting, and a subsequent special meeting, at which he moved a motion to repeal Rule 8, which said that the President should retire annually, and not be eligible for re-election after the second year. This motion was carried by 'a large majority' (FNCV Minutes 1880: 11 June 1883). Dobson's expressed purpose was to clear the way for McCoy to reassume the presidency (Dobson 1883). He then resigned, but this political manoeuvre did not work. It would seem that McCoy was not approached after the June meeting, because in September Dobson wrote to the committee asking that some action be taken on his letter of 6 July resigning his position. The committee decided that Dobson, J.F. Bailey and T.A.F. Leith should wait upon McCoy (FNCV Minutes 1880: 1 October 1883). A month later Bailey and Leith had not interviewed Dobson about the matter (FNCV Minutes 1880: 5 November 1883). Was it that they felt the situation was too delicate, or did the committee not really want McCoy back again? In December the secretary was directed to write to McCoy requesting him to name a place and time to discuss the matter (FNCV Minutes 1883: 3 December 1883). McCoy replied, explaining that while University duties had prevented him from making an appointment, he was referring to previous communications expressing objections to his reassuming the Presidency, which he found unanswerable, so while thanking the committee for thinking of him, he felt bound respectfully to decline (McCoy 1884a). There are several oddities about this. McCoy said that he thought the objections came from Dr Lucas. The 'previous communications' may refer back to 1881, when Lucas had proposed the alteration to Rule 8, limiting the tenure of the president to two years. The other part of the motion related to the Vice-Presidents, ruling that one of them should retire each year in rotation and not be eligible for re-election. This affected Lucas himself, but he had already retired from his position at the end of the first year in May. Lucas's motion was carried (FNCV Minutes 1880: 8 August 1881). McCoy would have been informed of this amendment, perhaps in the normal course of things, or because he would be directly affected at the end of the Club year in 1882, but the alteration was then presumably forgotten, or ignored, and McCoy was re-elected for a third term. It is likely that Lucas voiced his objection, but if so, there is no record of it. After the annual election in 1883 he was no longer a committee member, and although he was present at the special meeting when Rule 8 was repealed, he was not reported as taking part in the discussion.

Whether Thomas Lucas was motivated by personal reasons, or a desire to have things done in what he considered a right and proper manner, is unknown. He had had experience of field naturalists' clubs in England, where office-bearers may have been regularly replaced, or he may have felt that the Club would benefit by having a change to someone who would play a more direct part in its administration and activities. There may have been a philosophical antagonism between the two men, though there is very little evidence to support this. McCoy was staunchly opposed to Darwin's theory of evolution, while Lucas had grown up in an atmosphere of enquiry, with a father who was a Methodist minister and also a geologist, who gave a public lecture on 'Geology and Genesis' in which he attempted to reconcile the biblical account of the creation with history as read by the geologists (Lucas 1937). Lucas's published articles do not make clear what his views were. Perhaps he kept an open mind on the subject, but both he and McCoy were geologists, which could have provided matter for argument, especially in the climate of the times.

They were certainly opposed in their approach to natural science. McCoy had made his name by the prodigious amount of work he did in classifying the great collection of British fossils in the Woodwardian Museum, in Cambridge, which 'astonished' his collaborator, Adam Sedgwick, who wrote of 'this excellent naturalist', 'incomparable and most philosophical palaeontologist', the subsequent publication of the description of the collection, and an enormous number of articles in learned journals. McCoy was essentially 'a naturalist who worked indoors' (Fendley 1974). C.A. Topp, a member of the Club and a later President, who had been one of McCoy's students, said of McCoy that 'the only flowers exhibited in his lectures were the flowers of rhetoric' (Lucas 1937), while students in the 1880s complained that there were no geology excursions (Fendley 1974). Lucas, in addition to his geological interests, was an enthusiastic entomologist and ornithologist, who liked nothing better than to get out in the bush. His writings, couched in a flowery, exuberant style, reveal a sensuous as well as a scientific approach to nature.

McCoy was impetuous and quarrelsome (Blainey 1957). Lucas would also appear to have been intemperate (a not unusual effect of tuberculosis). A curious incident occurred at the Club's monthly meeting in January 1881. F.J. Williams had been elected at the first meeting of the Club, and was one of the 'original members'. In August 1880 he had written to the Club offering his services in procuring and preparing specimens of birds and animals (Williams 1880), and he enclosed a testimonial from McCoy who said that Williams had done this for the National Museum of Victoria, and that he was a 'most trustworthy and respectable man as well as a good bushman' (McCoy 1878). At the Club meeting Dudley Best read Williams' paper on the Marsupials of Australia. The record of the meeting said, rather dismissively, that 'although the writer added nothing new to what is already known of these animals, he had evidently carefully studied the subject' (FNCV Minutes 1880: 10 January 1881). Williams was in the audience, and was highly offended at the reception given to his paper. He wrote a letter to the committee protesting that the chairman (Lucas) had made 'some very disparaging personal remarks', about him and his orthography, but added that it was no more than was to be expected from a person who 'from the very first of this Club' had spoken 'most disrespectfully of Professor McCoy'. Williams then made some very disparaging remarks about Lucas, whom he considered to be 'somewhat proficient in dealing with sick and fancy Dogs' (Williams 1881)! Obviously several people's 'sensibilities' were touched on this occasion, but it does indicate that Lucas had some antipathy towards McCoy.

With McCoy declining the presidency, the committee asked Dobson if he would see out his term, which he did, and he gave the annual address in 1884. He wrote to McCoy to ask for advice on the direction which the Club's energies should take in the coming year (Dobson 1884). McCoy suggested a study of insects which were injurious to plants, both native and introduced, and in particular whether any of them were attacking imported plants in place of their native food. A study of galls would be equally useful, little having been done in this country (McCoy 1884c). The committee again approached McCoy to become President in 1884, after Mueller had refused the position, but again McCoy declined (McCoy 1884b).

Members of the Club found the National Museum a great resource. In March 1883 a visit was included in the programme, McCoy having 'expressed his willingness to personally receive such a visit' (FNCV Minutes 1880: 5 March 1883). Two years later, however, they were not so happy about the institution, and a deputation consisting of T.A.F. Leith, Dudley Best, Henry Watts and F.G.A. Barnard handed to the Trustees of the National Museum a statement of 'the most pressing reforms needed' (FNCV Minutes 1883: 2 March 1885). This was passed on to McCoy as Director, to which he duly replied. Lack of money and lack of space were the reasons for inadequate staff and the smallness of the library (though most of the works of reference were available in the Public Library). McCoy pointed out that the Sydney Museum had a staff of seventeen at a cost of £2,833 , while there were only eight staff in Melbourne at a cost of £1,230. £50 to £60 a year was available for the purchase of periodicals and books, compared to £500 in Sydney. He was 'astounded' at the criticism that all the specimens were not displayed and that Victorian entomology and oology were unrepresented. The finest collection of Victorian Entomology in the world was held in the museum, he said, adding that 'prominent members of the Field Naturalists Club' had been classifying their specimens from it for years. The collection of Oology was 'as perfect as I have been able to make it'. As to the suggestion that 'the nomenclature and classification should be brought up to the most recent determination' McCoy responded indignantly that no museum in the world could maintain this standard, but he felt sure that the National Museum came as near to this 'point of perfection' as any other great museum, and that it was his 'delight' to continually update the classification. In view of the amount of work involved, and the lack of assistants, this criticism does seem somewhat unjust. The collection of conchology (specifically mentioned in the submission) was the finest in the world, and the ornithological collection approached this. As to the final request that the *Prodromus of Zoology* appear more frequently, that was out of his hands, and the responsibility of the Government Printer, who had only one lithographic press-man (McCoy 1885).

In 1886 Mueller, who had declined the presidency of the Club five times, suggested to the committee that they make McCoy and himself patrons of the Club, thus representing 'the two great branches of animated natural history' (Mueller 1886). McCoy declined, or failed to reply, perhaps offended by the criticisms of the National Museum in the previous year (Taylor 1996). In 1889 they elected him to serve alongside Mueller, and McCoy wrote thanking them for 'the high compliment' (McCoy 1889). Any ruffled feelings over the museum were in the past, and Thomas Lucas had moved to Queensland for his health.

Whatever the relations between McCoy and the FNCV may have been from time to time, the Club did not fail to congratulate him when the occasion demanded. In 1883 they congratulated him on being awarded a Diploma of Honour at the Amsterdam Exhibition (FNCV Minutes 1880: 10 September 1883), and again in 1891 when he was knighted. There was some reflected glory for the Club on the latter occasion, Baldwin Spencer pointing out that there were only six or seven 'biological knights' and the FNCV had two of them in their patrons (Anon 1891). In 1946 the Club, together with the Royal Society of Victoria and the McCoy Society, renovated the memorial to McCoy in the Brighton cemetery, and on 1 June there was a ceremonial planting of native shrubs (FNCV 1946).

McCoy's last function in connection with the Club was his attendance at the 1896 conversazione, when he proposed a vote of thanks to his fellow patron, Mueller, for his inaugural speech (Anon 1896). He referred to the great help which field observers could be to the scientific specialist, a theme which he had pursued from the days of his Presidency.

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Frederick McCoy's Mount Macedon Property

Doug McCann[1]

Abstract
In the later part of his life Frederick McCoy selected and developed a bush block on the slopes of Mount Macedon. The conditions for purchase required him to plant and foster the growth of various northern hemisphere trees and shrubs. He duly cleared part of the block, planted trees, shrubs and grass, put up fencing, constructed a small reservoir and laid pipes. In 1876, having fulfilled government requirements, he purchased the property and retained ownership until 1890. (*The Victorian Naturalist* **118** (6), 2001, 319-321.)

Introduction

When Frederick McCoy first arrived in Melbourne in 1854 his living quarters in the grounds of the new University of Melbourne were not yet finished but upon completion he took up permanent residence. He lived on campus for a number of years then moved to his house 'Maritima' at Brighton (Brighton Beach) where he resided until his death on 13 May 1899. It is little known, and has not been previously noted in the biographical literature on McCoy, that he also owned a large bush block on the slopes of Mount Macedon.

Documents from the Department of Lands and Survey show that McCoy in 1874 selected land on the eastern slope of Mount Macedon which previously had been State Forest. The location was just north of what is now the township of Mount Macedon. The property covered two lots with a total area of 'sixteen acres five roods and thirty nine perches more or less being allotments three and four of Section five in the parish of Macedon County of Bourke'. Since the area was more than ten acres, a special licence was required for occupancy, which was granted on the condition that he improve the site and 'plant upon each and every acre of land hereunder at least ten (10) useful timber trees of the following kinds viz. *Cedrus Deodora* (sic), pines of all kinds and *Wellingtonia Gigantea* (sic) and shall foster the growth of such trees in accordance with any code of instructions that may be promulgated by the Board of Land and Works'. The reason that he had applied for a larger acreage, McCoy revealed, was 'to enable me to irrigate the plantations by bringing the water in pipes from the creek above the bridge'.

McCoy conscientiously went ahead with the obligatory 'improvements' such as clearing trees and scrub, planting new trees and fencing the property. In 1876 he submitted a schedule of improvements and associated costs, along with a request that the land be put up for sale by auction. The request was granted and McCoy purchased the land. Among the improvements he claimed to have carried out included planting '160 well-established 8 years old *Pinus insignis*'. Another improvement mentioned under the subheading 'Fencing', included the erection of ten chains of three-rail fences and forty chains of picket fences. Under the subheading 'Clearing etc', McCoy indicated that he:

> Paid Alfred Turner for tools, posts and rails and pickets, and labouring wages, and superintending their work of felling and grubbing trees, cutting up and burning fallen timber, cutting ferns and scrub, ploughing, harrowing and sowing with grass seed, carting off stones, putting up fencing etc.

Included on his list of improvements and expenses were:

> Two and a half years travelling, personal and miscellaneous expenses incurred in supervising and directing the various works on ground, laying out paths, marking foundations, taking levels for bringing down water supply etc etc.

The Reservoir

One of the most interesting items listed in the documents quoted above is the reference to provision of a water supply. McCoy supervised the construction of a small reservoir in a well-elevated position just above and towards the eastern side of

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the property to store and divert water from the Turitable Creek so that there would be a reliable irrigation source for his newly established northern hemisphere plants. The Turitable Creek is a small stream with a steep gradient that has its origin further up the mountain and winds downhill to form the western boundary of the block. This moderate capacity, but neatly built, reservoir still exists, along with some of the original earthenware pipes, although everything is now largely silted up. The reservoir itself is skilfully constructed from local stone with perfect formwork to create walls and spillway. The stone used (probably dacite) was capably crafted and precisely assembled to provide a functional dam and a dependable water supply that McCoy and his exotic plants would have found welcome, especially during the harsh Australian summer.

Projecting from the lower part of the dam wall is an earthenware pipe with a valve which, when closed, allows the reservoir to fill and divert water to the western side of the dam to an underground pipeline outlet with a second valve to regulate flow. The pipes are approximately ten inches in diameter and the buried pipeline runs downhill to the lower parts of McCoy's original block. Water was piped down from the reservoir to supply water for the recently planted trees and shrubs, many of which are still extant.

The trees

One tree that was almost certainly planted by McCoy is a California Redwood *Sequoiadendron gigantea*. One can only speculate, but the Sequoia was probably acquired through the agency of Ferdinand von Mueller. Other trees of a similar vintage, and therefore probably also planted by McCoy, include English Oak, White Oak, Negrohead Beech *Nothofagus moorei* and Rhododendron. There is also another slightly younger group of trees that have been estimated, by a later owner of the block, Reg Hume, to be in excess of 100 years old, and may also have been McCoy's handiwork, but these are less certain. These include trees such as English Maple, English Beech, Sweet Chestnut, Horizontal Elm and Variegated Holly. There are many other trees and shrubs which are much younger and were planted after McCoy's time.

As well as the exotic trees and shrubs there is also a great deal of native vegetation, particularly towards the back of the property adjoining the Turitable Creek. The natives include Messmate *Eucalyptus obliqua*, Manna Gum *E. viminalis*, acacias such as Silver Wattle *Acacia dealbata*, Blackwood *A. melanoxylon*, Prickly Moses *A. verticillata*, a distinctive heavy understorey of Hazel Pomaderris *Pomaderris aspera* and various other shrubs, ferns and fungi. Altogether there is a pleasing blend of northern hemisphere trees and native vegetation. McCoy, in his earlier years in the Colony of Victoria, was an enthusiastic advocate for the introduction of european (especially English) plants and animals. He was a former president of the Acclimatisation Society (see Gillbank *this issue*). He would have been proud of his achievement in taming and 'beautifying' the wilds of Mount Macedon (although many of his introduced species are now invading native forest).

Concluding remarks

As McCoy indicated in the documents cited above, he commuted from Melbourne to his Macedon bush block, at least during the first couple of years when he was instituting his improvements. So far nothing has been found to suggest that McCoy and his family ever lived there or constructed a dwelling, temporary or otherwise. He retained ownership of the land until 1890. For many privileged nineteenth century Victorians like McCoy the idea of owning a mountain property where one could escape the city and enjoy the coolness and shade of a fern gully beside a gently flowing creek was an attractive proposition. Possibly, at this stage of his life, he used the property purely for recreational purposes but it is also probable that, being the uncompromising and irrepressible naturalist that he was, he treated it as his own private field study area as well as a recreational venture.

The current name of the property is 'Cooinda' but again there is nothing to indicate whether it was McCoy or a later owner who gave it this title. Several eminent Victorians since McCoy have owned the property, including Sir Edward and Lady Eliza Mitchell, who purchased it in 1902, and Reg and Margaret Hume, who purchased it in 1964. Reg Hume built a new home, planted many new trees and shrubs, and arranged for tree surgery to save some of the older trees that had been affected by fire or disease. Some of the older trees were lost in the Ash Wednesday fires in 1983 and Reg Hume applied himself with great devotion and energy to restore and save those that he could. Several subdivisions of the block have taken place but there is still a large section of the original that remains intact. The property was, and remains in part, a memorial to Frederick McCoy's love of northern hemisphere trees.

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The History of the McCoy Society

David H. Ashton[1]

Introduction

In 1935 Raymond Priestley, the Vice Chancellor of Melbourne University, suggested that a Society for the Study of Field Investigation and Research be set up and on 9 July of that year the first meeting was duly held in the Zoology School. The name was changed later to the McCoy Society in honour of the first professor of Natural Science at Melbourne University in 1854. McCoy's specialty was geology and his interests were broad, such that he made demands for and obtained a museum for the University and a Botanic Garden.

The inaugural meeting was held in the Zoology School on 10 August with Professor Wood Jones of the Anatomy Department as president. Notable members of the Melbourne University Departments of Botany, Zoology and Geology were present, as well as many other interested people outside the University, such as medics and school teachers. Professor Wood Jones was the driving force and soon garnered sufficient funds to purchase camping equipment including the great marquee, tents, trestle tables, cooking gear and 'thunder boxes'. At that time, membership was limited to 50 and many famous names headed the list, such as Professor Oscar Tiegs, Dr Reuben Patton, Miss Maisie Fawcett, Dr Gwyneth Buchanan, and Associate Professor Fred Singleton. Professor Wood Jones was of the opinion that islands made the best venues for study since they were easily definable, somewhat inaccessible and intrinsically interesting in terms of their formation, their biota, species dispersal and general ecology. Work needed to be clearly focussed, and being multi-disciplinary, was stimulating and useful to the advancement of Australian Science. Whenever land-based projects were undertaken however, they became open-ended and too big to complete.

The activity of the Society can be divided roughly into four general phases:

A. Island expeditions 1930s;
B. War-time excursions 1940s;
C. Land-based projects 1950s;
D. Return to island expeditions 1960s, 1990s.

Without doubt the recruitment of undergraduates and postgraduates contributed to the momentum of and interest in the Society. It had a dynamic population with senior staff of university departments maintaining the continuity.

In the early years field work was something of a novelty and the strength of the Society lay in the interaction of a number of disciplines. In later years field work in many departments became more common and the incentive to work collectively

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diminished as other competing commitments developed. After 1970 general interest faded away and moreover, the National Australia Bank continued to complain about the Society's 'moribund account'. Therefore in 1992, as the last president and committee member, I resolved to complete the McCoy Society's contributions by a study of Pelican Island in Western Port, along much the same lines as the initial study on Lady Julia Percy Island. Following several years' work the results were published, the McCoy account was closed down and the residue of funds donated to the library of the Royal Society of Victoria.

The following account is compiled from my own recollections and photographs as well as those of various members of the Society. Much material was also gleaned from letters and minutes and photographs stored in the Archives of the University of Melbourne.

A. Island expeditions – the pre-war years, 1935-1939

Camping expeditions to islands off the south east Australian coast were mounted every long vacation over these years.

1. Lady Julia Percy Island, 1935-1936

This was an intrepid expedition lasting two months in summer 1935-36. It set off from Port Fairy after a rousing civic reception by the mayor of Port Fairy and the Secretary of the Progress Association. After a rough 19 km boat trip stores were landed from a dinghy and hauled up 30 m cliffs to the camp site on the exposed, flat-topped, basalt terrain.

The island was surveyed and geology, botany, zoology studied, together with some pioneering work on soil bacteriology (Fig. 1). Vegetation was relatively simple and consisted mainly of grassland, bracken fernland, and near the shoreline, succulent herbfield. Of interest were the large colonies of fairy penguins, mutton birds and Australian fur seals. Rabbits, introduced in 1868, were present in plague proportions. The work was published in the 1938 *Proceedings of the Royal Society of Victoria*.

The island was visited by a group of naturalists in 1965 and again two years later after a very severe drought (Pescott 1965, 1968). The plant communities were generally similar to those three decades earlier although severe damage was caused by the drought. Rabbit numbers had been reduced in 1965, presumably by myxomatosis, but by 1967 they had increased enormously and were now starving. Grasses were decimated and succulents severely grazed. Over the period of 27 years the number of vascular plant species had increased from 32 to 84 and the contribution of alien species increased from 12 to 45%. The

Fig. 1. Members of the McCoy Society on the first expedition to Lady Julia Percy Island, 1935-36. Centre, Irene Dewhurst; extreme right, Associate Professor Fred Singleton. Other names not known.

diversity of birds recorded was generally similar and eight of the major species were common to both studies.

As pointed out by Dr Sophie C. Ducker, a tapestry by the wife of one of the members of the original expedition, Eugenie La Gerche, depicting a map of the plant communities of Lady Julia Percy Island, at present hangs in the office of the Dean of Science at Melbourne University.

2. Sir Joseph Banks Islands off Port Lincoln, 1936-37

This was a major and expensive expedition which lasted two months and coincided with South Australia's Centenary celebrations. It concentrated on two Islands of the group, Reevsby and Kirkby Islands, both of which were of low relief and consisted of calcarenite over a granitic base. In this relatively dry environment vegetation consisted of coastal grasses and scrub (e.g. *Atriplex paludosa*, *Olearia axillaris*), with an almost total lack of trees. The botany of the islands was described and detailed studies made on marine communities as well as birds, reptiles, seals and penguins. The combined work, again under the leadership of Professor Wood Jones, was published in the *Proceedings of the Royal Society of Victoria* in 1939.

3. King Island, Bass Strait, 1937-38

This expedition involved many well-known zoologists (Professor Buchanan, Charles Birch, George Wade, Jim Guest) as well as botanists and geologists. Studies were made in wet sclerophyll forest where the East Gippsland Olive Berry *Elaeocarpus reticulatus* occurs. The Tasmanian Celery-top Pine *Phyllocladus aspleniifolia* was present before numerous destructive fires. Marine algae were collected and reptiles, insects, frogs and birds were studied in the reed swamps and marshes. The onset of World War 2 prevented any of this work from being published.

4. Sunday Island, Corner Inlet, 1938-39

This island provided an opportunity to assess the concepts of plant succession in a coastal sand dune environment. It was led by the new, young Professor of Botany, J.S. Turner, in the severe drought and fire-prone summer of 1938-39. The camp was based on a deserted house of the early pastoralists. After the war, a follow-up expedition took place in February 1947 with botanists, zoologists and geographers. The input of Dr Eric Bird in the late 50s provided a great impetus for the completion of this work on the role of geomorphology and soil formation in the succession of plant communities from grassland of the foredunes to sclerophyll woodlands of *Eucalyptus viminalis* and *Banksia serrata* in the hinterland. It was finally published by Turner, Carr and Bird in the *Proceedings of the Royal Society of Victoria* in 1962.

B. The War Years, the 1940s

1. Walpeup Research Station, 1943

A group travelled by train to Walpeup and obtained enough petrol coupons to undertake trips to the Pine-Belar and Mallee communities nearby as well as the Pink Lakes and the sand hill country to the south. Vegetation, bird life and entomology were studied but not written up.

2. Cathedral Range, Buxton, 1947

A camp was set up beside the Little River which allowed access to wet forest (*E. viminalis*) in the valley and dry stringybark forest (*E. macrorhyncha*) on the sandstone range. Of interest was the patch of dwarfed Snow Gum *E. niphophila* on the Sugarloaf at 610 m. The area was diverse, the roads atrocious and the camp rendered exciting by the visitation one night of local yahoos intent on cutting tent ropes. Needless to say they were repelled with some vigour by one of the members (Neville Walters), brandishing his ghurka knife. This trip was my introduction to the Society as a student about to start third year science.

3. The Black Range, Grampians 1948-49

This camping expedition involved many University botanists, zoologists and geologists – staff, postgraduates and undergraduates. The camp was set up at Cherrypool - a corruption of the Aboriginal 'Cherapol' meaning big water (Fig. 2). One seasoned field geologist, Peter Crohn, was heard to say 'the first one in for a swim gets all the leeches'. Mercifully in that long hot summer there were none. Vegetation was related to soils and geomorphölgy and ranged from stringybark (*E. obliqua*), sclerophyll woodlands (*E. baxteri*), cypress pine (*Callitris rhomboidea*) on the sandstone

Fig. 2. McCoy Society camp at Cherrypool, the Black Range, Grampians, 1948.

range to grassy woodlands of Yellow Gum *E. leucoxylon* and Red Gum *E. camaldulensis* on the adjacent plains. A follow-up trip took place in 1949 but difficulties with bogged vehicles took the edge off the enthusiasm. The project became too big and open-ended and finally lapsed.

C. Land-based expeditions of the 1950s (apart from Phillip Island)

These varied from the Western District to Wilson's Promontory.

1. The Rhyll Salt Marshes, Phillip Island, 1950

This was a short excursion to study the communities of the salt marsh and mangroves under the leadership of Kingsley Rowan. It involved studies of point quadrat quantitative ecology by the brilliant Dr David Goodall.

2. Lake Purrumbeete, Camperdown, 1951-54

Maisie Fawcett encouraged a study of the limnology of this lake where quinnet salmon had shown very impressive growth rates. The first camping expedition was based at the Fisherman's Reserve in summer 1951 during which the prevalence of tiger snakes caused a great deal of excitement. The shoreline and tall submerged aquatic vegetation was mapped, bird populations assessed, and the geology of the maar and surrounding tuff deposits investigated as well as the chemistry of the lake. Subsequent trips in 1952 and 1954 were based on Manifold's property and a small shed was built to store equipment. A boat was used to sample the lake environment and algal plankton such as *Microcystis*. The work clearly demonstrated the existence of a thermocline in summer and its absence in winter. Data was gathered on oxygen levels using methylene blue titrations. However, once again the project became too large and open-ended and other research work competed for time that could be devoted to it. The study lapsed and this pioneering work was taken up by other research workers in later years.

3. Excursion to Chinaman's Island, Warneet, 1957

This was a day excursion to reconnoitre the heathy manna gum woodland and the surrounding mangroves, some of which were anchored in the lateritic rock of the shore platform.

4. Waterloo Bay, Wilson's Promontory, 1958

The was a fairly large expedition, most arriving by boat from Port Welshpool – the small group who trekked in later by land with the perishable supplies lost the track and spent a memorable night in the bush. The work was mainly reconnaissance involving botanists, zoologists and geologists.

5. Mt Hunter Peninsula, Wilson's Promontory, 1959-63

This was undertaken with some enthusiasm and provided a venue to study vegetation which had escaped the disastrous fires of 1951. The camp was set up near Lawson's Creek after the group was forced by low tide to carry gear some hundreds of metres, being harried all the while by hordes of voracious march flies. The geology and geomorphology was studied, including the old tin mine site, granitic features, hillwash deposits and sand dunes. The area was surveyed and plant communities mapped as heath, wet and dry sclerophyll forest (*E. obliqua*), sclerophyll woodland (*Banksia serrata*), coastal scrub, swamp and fern gully, the latter being dominated by columns of climbing fern (*Gleichenia microphylla*) along Lawson's Creek. Of considerable interest was the series of beach ridges and dunes at Entrance Point, which showed both the build-up and truncation of dunes as well as soil podzolization consistent with a successional interpretation. Nutrient-rich dune slacks were dominated by mesophytic fen vegetation of *Sium latifolia*, *Urtica incisa*, *Typha latifolia* and *Phragmites australis* which contrasted with the sclerophyllous and sedge-dominated, acid brown swamps on granite to the south. Mt Hunter vegetation demonstrated a dramatic effect of aspect and exposure with the occurrence of heath on the north face, tall *E. obliqua* forest on the south, and fern-rich (*Gleichenia dicarpa*) heath reminiscent of Tasmania on the eastern and southern spurs. *Australina pusilla* var. *muelleri* occurred in the fern gully on Mount Hunter, whereas in other areas of the Promontory it is replaced by *A. pusilla* var. *pusilla*, as in wet forests of Tasmania. The heath and sclerophyll woodlands showed abundant evidence of invasion by coast tea-tree, similar to other areas on the Promontory.

In March 1962 the whole area was razed by a wildfire burning north from Mount Margaret. The camping site was revisited the next year and the vegetation regeneration assessed (Fig. 3). The fine layers of powdered charcoal pervaded all clothing, equipment and skin. The density of Coast Tea Tree *L. laevigatum* regeneration was calculated to be of the order of 12 million seedlings per hectare, vying in size and density with the capsules of the fire moss, *Funaria hygrometrica*. This area was monitored over the ensuing 12 years and results included in a manuscript on sand dune ecology on Wilson's Promontory at present under review. The general project however, became large and difficult to sustain and unfortunately was not written up for publication.

Fig. 3. Heath plateau (burnt out grassy aspect), Mt Hunter, heath to west, tall dry sclerophyll forest to east.

D. Return to island ecological research 1960s, 1990s

These involved camping expeditions to the Bass Strait islands and repeated day excursions to Western Port.

1. Hogan Island, 1968

This expedition was undertaken from Port Welshpool for two weeks in January 1968. Most work was done on Hogan Island (Fig. 4) but short trips were made to nearby islands - Long, East, Round and Twin Islands. Vegetation communities were mapped on granite and calcarenite. A small peaty soak provided material for pollen analysis down to a depth of 70 cm. Vegetation was predominantly tussock grassland (*Poa poiformis*, *Stipa teretifolia*), low shrubland (*Marrubium vulgare*), succulent herbfield (*Disphyma australe*) and remnant paperbark (*Melaleuca ericifolia*). There was abundant evidence of human interference through burning and grazing activity, rare shrubby areas occurring only in protected rocky niches. The results of pollen analysis by Geoff Hope suggested that the increase in weedy species (*Rumex*, *Marrubium* and probably *Hypochoeris*) was commensurate with pas-

Fig. 4. East coast at Hogan Island, 1968.

toral activities post-1835. Various aspects of the research were published in 1974 in the *Papers and Proceedings of the Royal Society of Tasmania*, because being Tasmanian territory it was deemed unsuitable at that time for the Victorian *Proceedings*.

2. Curtis Island, 1971

This expedition was initiated by Dr Jack Massey of the Geography Department, Melbourne University. Landing was effected on the rugged coast with considerable difficulty and skill. The island, rising to 350 m, was more varied than Hogan Island and probably received more rainfall. Soils were skeletal and vegetation consisted of tussock grassland, areas of *Melaleuca armillaris* scrub and succulent coastal herbfield. This scrub was the western limit of this species from the east coast of Australia. Other species (*Ixiolaena supina* and *Albizzia lophantha*) provided links with islands off the Western Australian coast. This research was also published in the Tasmanian *Proceedings* in 1974, and included work of an ancillary trip by Dr Jamie Kirkpatrick on Rodondo Island.

3. Pelican Island, Western Port, 1992-98

This intriguing but very small island had been frequently observed from the Corinella-French Island punt and assumed to be salt marsh and paper bark. It was decided in the late 80s that it might make a good venue for a last expedition of the McCoy Society. The initial trip by fishing boat in 1992 involved a large contingent from the Melbourne University Botany School, who surveyed the vegetation, soils and geomorphology of the island. Rocky salt marsh on the basaltic shore platform was backed by tussock grass (*Poa poiformis* and *Stipa teretifolia*) which surrounded open, somewhat decadent scrub of Blackwood *Acacia melanoxylon*, *Lavatera arborea* and *Clematis microphylla*. Weedy grasses were common in many parts. The island, up to 2 m above sea level, was composed of basalt boulders and cobbles built up from core stones derived from basalt hexagon columns of the shore platform. An area of peaty soil in between hummocks had been mined for fertiliser in the 1920s and overlayed silts which were probably old salt marshes formed when the sea level was higher and the island was being built up. The blackwood scrub flowered prolifically but set seed was very rare - due probably to the effects of salt aerosols. Blackwood bushes were severely attacked by wood-boring larvae and regeneration took place entirely by root suckers. Genetic analysis suggested that the population consisted of two groups probably a founder-effect of chance distribution from the mainland when sea levels fell. After six years of research, this work was published in the *Proceedings of the Royal Society of Victoria*, 1999.

Conclusions

For over 53 years the McCoy Society provided an important venue for the pooling of ideas and cooperative field research between diverse disciplines. The value of such interactions cannot be over-emphasised in the present-day climate of specialisation and economic rationalism where work tends to be done in isolation and with limited budgets. Although the Society has been formally disbanded, the door is still open for its re-emergence should a group of keen people so desire.

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Captions for Colour Plates

Plate 1. *Prodromus of the Zoology of Victoria*, Volume II, Decade XX. Plate 198. Lithograph by A. Bartholomew and Dr J.J. Wild under the direction of Professor McCoy, printed by Government Printing Office. Australian Admiral Butterfly *Pyrameis itea* (figs. 1-4); The Blue-spotted Painted-Lady Butterfly *Pyrameis Kershawi* (McCoy) (figs. 5-8).

Plate 2. *Prodromus of the Zoology of Victoria*, Volume II, Decade XVI. Plate 160. Lithograph by Dr J.J. Wild under the direction of Professor McCoy, printed by Government Printing Office. The Yarra Spiny Cray-fish *Astacopsis serratus* (Shaw sp.), var. *yarraensis* (McCoy).

Plate 3. *Prodromus of the Zoology of Victoria*, Volume I, Decade VI. Plate 53. Lithograph by A. Bartholomew under the direction of Professor McCoy, printed by G. Troedel & Co. The Green and Golden Bell-frog *Ranoidea aurea*.

Plate 4. *Prodromus of the Zoology of Victoria*, Volume I, Decade I. Plate 8. Lithograph by A. Bartholomew under the direction of Professor McCoy, printed by H.G. DeGruchy & Co. Lewin's Day-moth *Agarista Lewini* (figs. 1-4); The Loranthus Day-moth *Agarista casuarinæ* (figs. 5-8); The Vine Day-moth *Agarista glycine* (figs. 9-13).

Plate 5. *Prodromus of the Zoology of Victoria*, Volume I, Decade VIII. Plate 82. Lithograph by Dr J.J. Wild under the direction of Professor McCoy, printed by Government Printing Office. The Murray Tortoise *Chelymys Macquaria* (side view).

Plate 6. (top) *Prodromus of the Zoology of Victoria*, Volume I, Decade VIII. Plate 83. Lithograph by Dr J.J. Wild under the direction of Professor McCoy, printed by Government Printing Office. The Murray Tortoise *Chelymys Macquaria* (ventral and dorsal view).

Plate 6. (bottom) Helmeted Honeyeater. *Ptilotis cassidix* (*Lichenostomus melanops cassidix*). From John *Gould's Birds of Australia* Supplement (1867). Photographed at Museum Victoria by Anne Morton.

Plate 7. *Prodromus of the Zoology of Victoria*, Volume II, Decade XVI. Plate 151. Lithograph by Dr Wild under the direction of Professor McCoy, printed by Government Printing Office. Gould's Monitor Lizard *Monitor Gouldi*.

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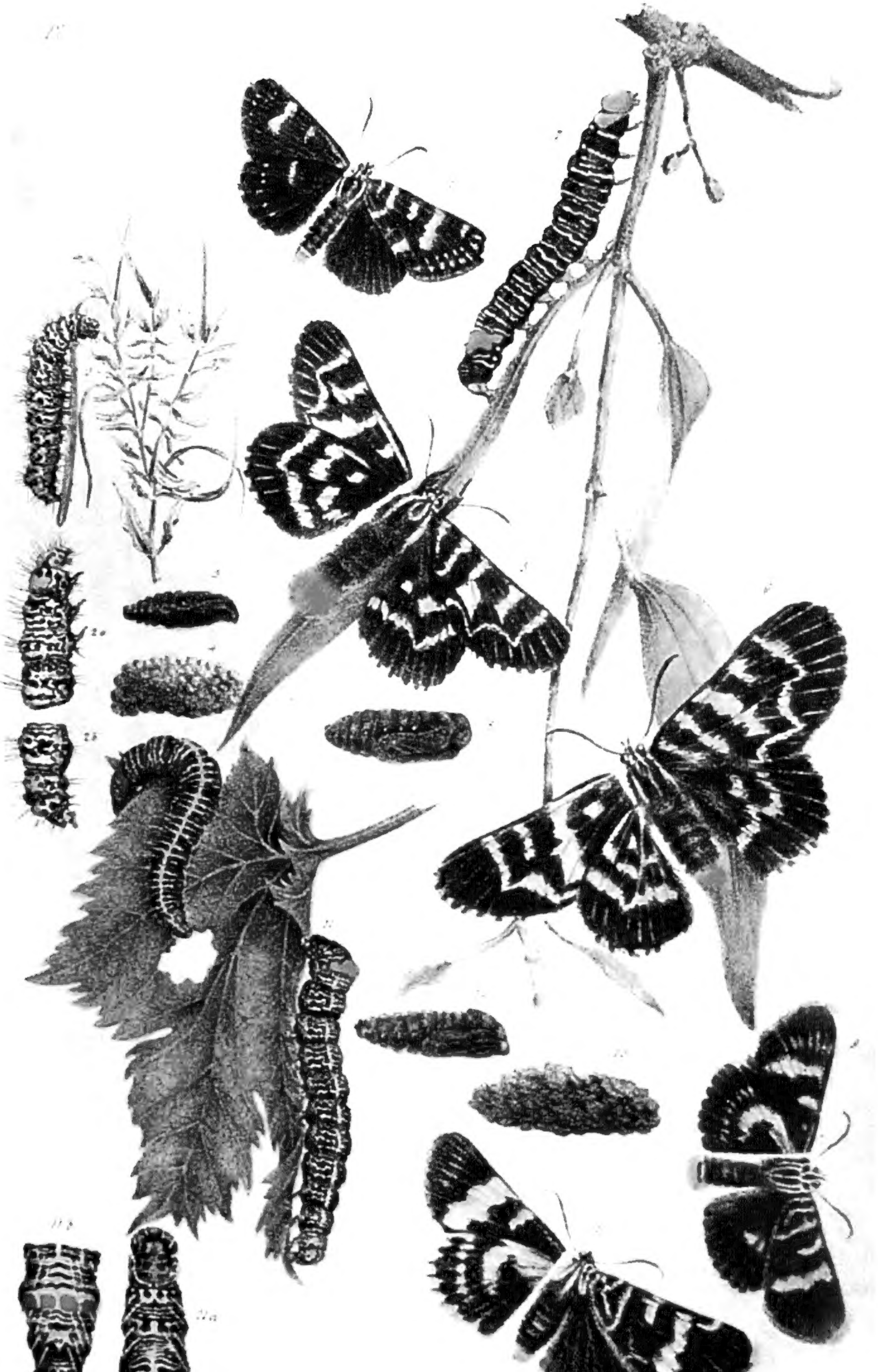

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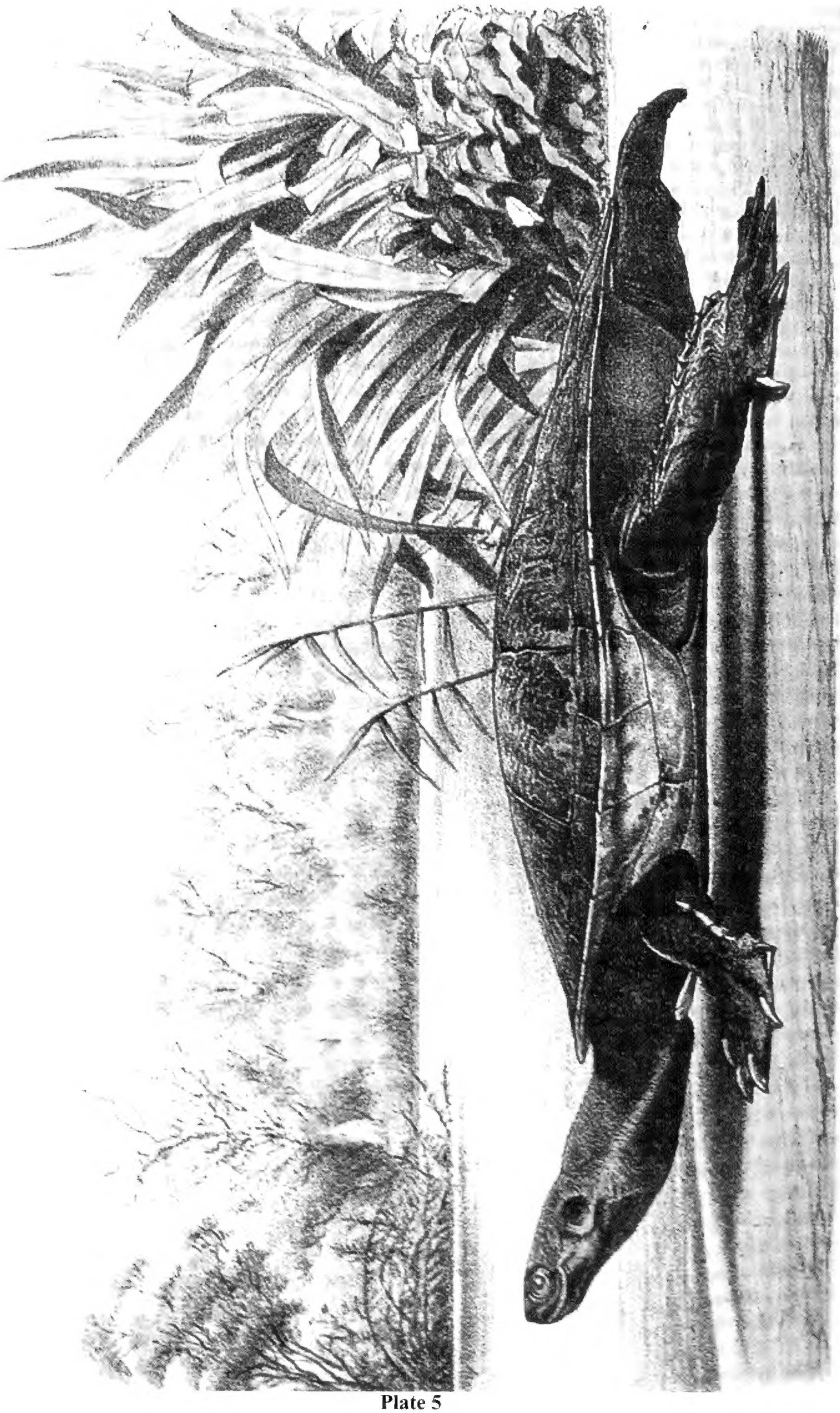

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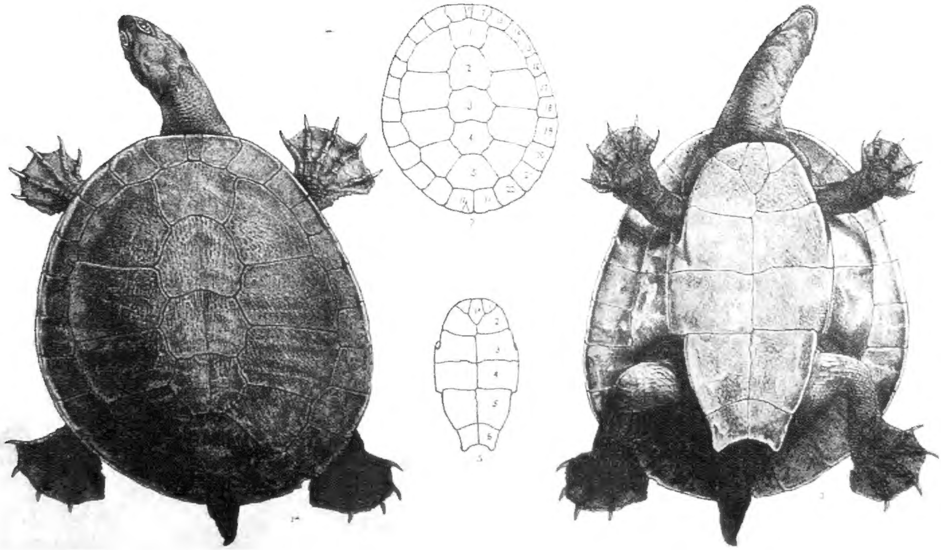

Plate 6

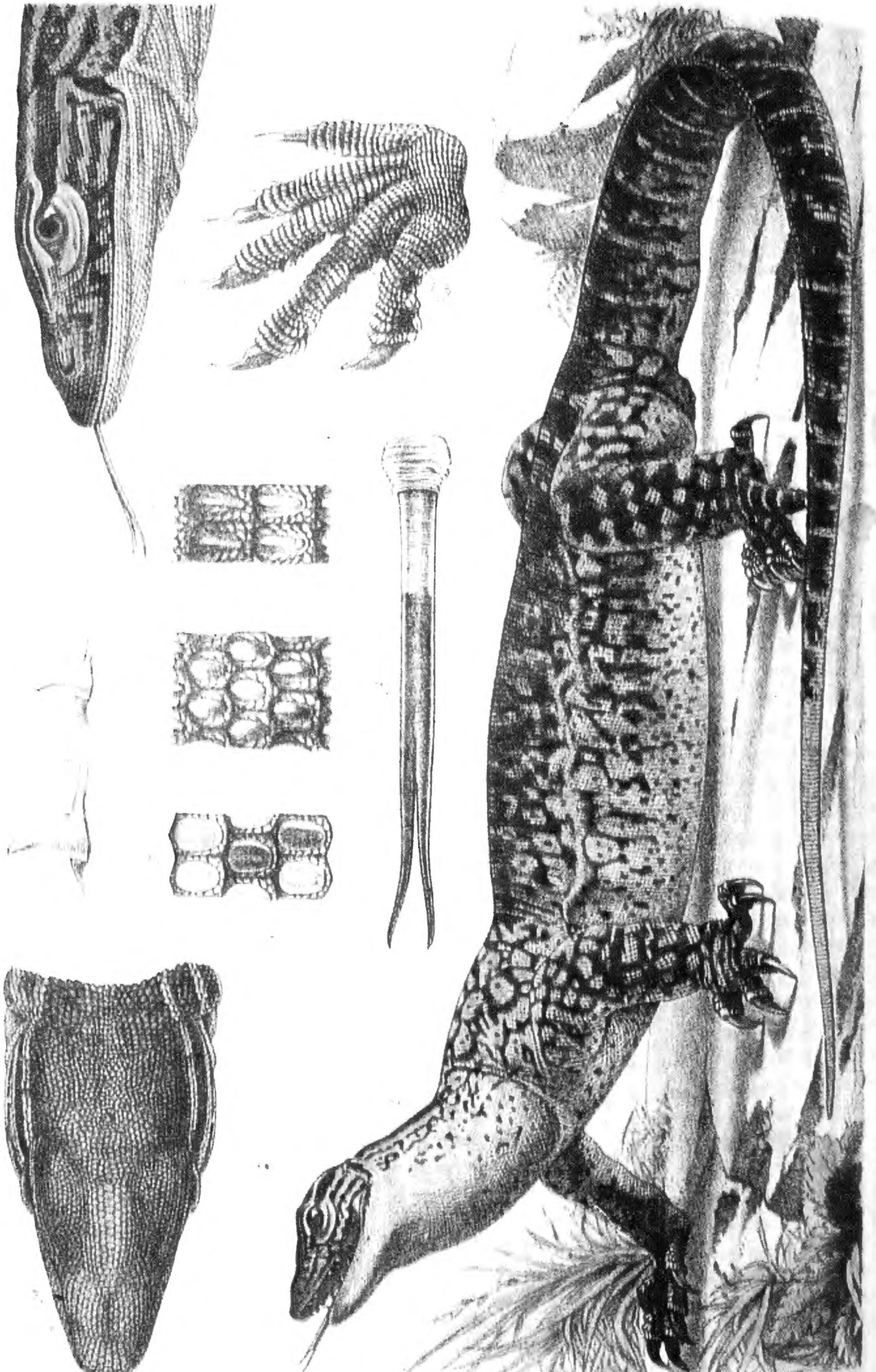

Plate 7